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REPORT UPON
WASTE WATER TREATMENT

for the

VILLAGE OF MONSANTO, ILLINOIS

November 3, 1960

VS0537

Metcalf & Eddy
Engineers
Boston, Massachusetts

LETTER OF TRANSMITTAL

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ENGINEERS

STATLER BUILDING
BOSTON 16 · MASSACHUSETTS

November 3, 1960

Leo Sauget, Esquire
Mayor
Village of Monsanto
East St. Louis, Illinois

Dear Mayor Sauget:

In accordance with agreements between the Village of Monsanto and Metcalf & Eddy, we submit herewith a report of our comprehensive studies concerned with treatment of waste waters within the Village of Monsanto.

Very truly yours,

METCALF & EDDY

By John S. Bethel, Jr.
John S. Bethel, Jr.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

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Conclusions.

1. Waste waters of the Village of Monsanto can be treated to meet the requirements of the Mississippi River at a cost that is reasonable.

2. Pollutants of concern are phenols, acidity, suspended solids, BOD, copper and zinc.

3. The Monsanto Chemical Co. is a major contributor of phenols, suspended solids and BOD, and mineral acidity. Waste water flows average 24.60 mgd.

4. The Mobil-Oil Co. is a significant contributor of phenols, suspended solids, and BOD. Waste water flows average 1.51 mgd. and are generally alkaline.

5. The Midwest Rubber Reclaiming Co. is a major contributor of suspended solids. Waste water flows average 3.60 mgd. and contain appreciable amounts of BOD and zinc.

6. The American Zinc Co. contributes significant amounts of suspended solids and zinc. Waste water flows average 5.42 mgd.

7. The Lewin Mathes Co. is a significant contributor of copper and zinc. Waste water flows average 2.98 mgd.

8. The Darling Fertilizer Company's waste water flows average 0.04 mgd. and are comparable to strong domestic sewage.

9. The Sterling Steel Casting Co.'s waste water flows range from 0.01 to 0.10 mgd. and are typical of domestic wastes.

10. Domestic and commercial flows total approximately 0.04 mgd.

11. The average total waste water flow rate is approximately 38.0 mgd.

12. Biological treatment of the wastes is required to reduce phenol levels to values acceptable for discharge to the Mississippi River.

13. Economic and feasibility considerations favor the adoption of the activated sludge treatment process over trickling filters.

14. Metal bearing wastes require only primary treatment to meet the requirements established for the Mississippi River.

15. Segregation of phenol-acid bearing wastes from metal bearing wastes is economically advantageous.

16. The design of the phenol-acid bearing waste portion of the treatment plant should be based on a flow of 26.0 mgd.

17. The design of the metal bearing waste portion of the treatment plant should be based on a flow of 12.0 mgd., or less, provided guarantees of water conservation can be obtained to justify a design for smaller flows.

18. Water conservation practices would significantly reduce the recommended metal bearing waste design flow but would have little effect on the volume of phenol bearing wastes.

19. Drying of sludge by lagooning and final disposal by landfill is more economical than vacuum filtration, with or without incineration, or pumping the sludge to the proposed East St. Louis Central Processing Plant of the East Side Levee and Sanitary District.

20. Waste activated sludge can be disposed of to the Mississippi River with no harmful effect.

21. The combined final effluent from separate treatment of the metal bearing wastes and the phenol-acid bearing wastes, including waste activated sludge, would be of a quality equal to or superior to that from primary treatment plants in the St. Louis area.

22. With separate treatment of wastes and disposal of primary sludge by lagooning and landfill the 122 acre tract of land at the proposed treatment plant site should be adequate for at least 40 years.

23. Development of waste treatment facilities at Monsanto should make it a favorable location for new industries.

Recommendations.

1. Provide for segregation and separate treatment of wastes on the basis of metal, phenol, and acid content. This would be accomplished as follows:

   a. Modify the existing sewerage system to segregate the metal bearing wastes from the phenol-acid bearing wastes.

   b. Provide primary treatment only for the metal bearing wastes.

   c. Provide primary treatment, neutralization, and activated sludge treatment for the phenol-acid bearing wastes.

2. Provide sludge lagoons for primary sludges only. Waste excess activated sludge to the Mississippi River with the plant effluents.

3. Purchase the 122 acres of land adjacent to the existing Main Pumping Station between the Alton and Southern Railroad and Monsanto Avenue, and between the Terminal Railroad and the Gulf, Mobile and Ohio railroad yards.

4. Determine the proportion of the costs to be financed by General Obligation Bonds, retired by moneys obtained from general taxation, and by Revenue Bonds, retired by moneys obtained from service charges to waste contributors.

5. Assess service charges based on flow and the waste water characteristics of phenol, BOD, acidity, suspended solids, zinc and copper, except for purely domestic waste contributors. Assess the latter for flow only at a special rate.

6. Commence the collection of service charges as soon as practical after approval of the program by the voters.

7. Prior to design obtain firm commitments from each industry regarding flows and the character of the wastes to be discharged to the sewerage system.

8. Obtain a decision from the Corps of Engineers regarding their proposed changes to the flood pumping station facilities.

9. In consideration of the rising trend of costs, the program should proceed as expeditiously as possible.

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REPORT

REPORT UPON WASTE WATER TREATMENT FOR THE VILLAGE OF MONSANTO, ILLINOIS

AUTHORIZATION

In accordance with agreements reached between the Village of Monsanto and Metcalf & Eddy on December 15, 1959, we have conducted a survey to determine the volumes and character of the waste waters discharged from the several industries located in Monsanto Village and have conferred with representatives of the Illinois State Sanitary Water Board relative to requirements for discharge of the waste waters of the Village to the Mississippi River in an acceptable manner. We have conducted laboratory scale experiments on treatment methods that allow us to conclude that the waste waters of Monsanto Village can be treated to meet the requirements for discharge into the Mississippi River at a cost that is reasonable. A complete account of our investigations, conclusions, and recommendations is incorporated in the report which follows.

SCOPE

This investigation was designed to determine the following:

1. Volume of waste waters from each industry.
2. Character of waste waters from each industry.
3. Requirements for discharge of waste waters to the Mississippi River.
4. Methods of treating waste waters.
5. Capital and operating costs.
6. Recommended method of waste treatment
7. Recommended method of financing.

REQUIREMENTS FOR DISCHARGE OF WASTE WATERS TO MISSISSIPPI RIVER

At the outset of the investigation it was deemed pertinent to establish what the existing requirements were for discharge of Monsanto Village waste waters to the Mississippi River, and to inquire whether additional requirements might be imposed in the near future. As the result of conferences with representatives of the State Sanitary Water Board in Springfield, it was established that the objectives of waste treatment should be as follows:

1. To remove all material which will float.
2. To remove all settleable solids which will cause formation of sludge banks or in any way indicate they are of sanitary origin.
3. To reduce the amount of toxic metals or compounds to levels not detrimental to aquatic life.
4. To reduce the amount of phenolic-type compounds to levels such that the concentration of phenol in the Mississippi River at minimum flow of 45,000 cfs. (cubic feet per second), will not exceed 2 ppb. (parts per billion), or less than 500 pounds per day.

VOLUME OF WASTE WATERS

The volume of waste waters discharged by each of the industries was determined by a variety of methods depending upon the particular circumstances. In most cases the flows were measured by means of weirs or depth measurements in sewers, using recording bubbler gages to give the depth of liquid flowing over the weir or in the sewer. Where measurements were made in sewers, the velocity of flow was determined under a given set of conditions by using the lithium chloride dilution technique developed by Mr. Paul Hodges, Waste Control Engineer, of Monsanto Chemical Company. The data obtained allowed calculation of Kutter's "n" values (coefficient of friction) for the various sewers and, with this value, it was possible to translate depth of flow, as measured by bubbler gages, to a volumetric basis.

The flows from small contributors were estimated from water meter records. In one instance the flow was estimated from the increase in temperature, since the amount of heat transferred to the water during use was known.

A discussion of the method of measuring or estimating the flows from each of the contributors follows. Reference to Fig. 1 showing the existing sewer system of Monsanto Village will be helpful.

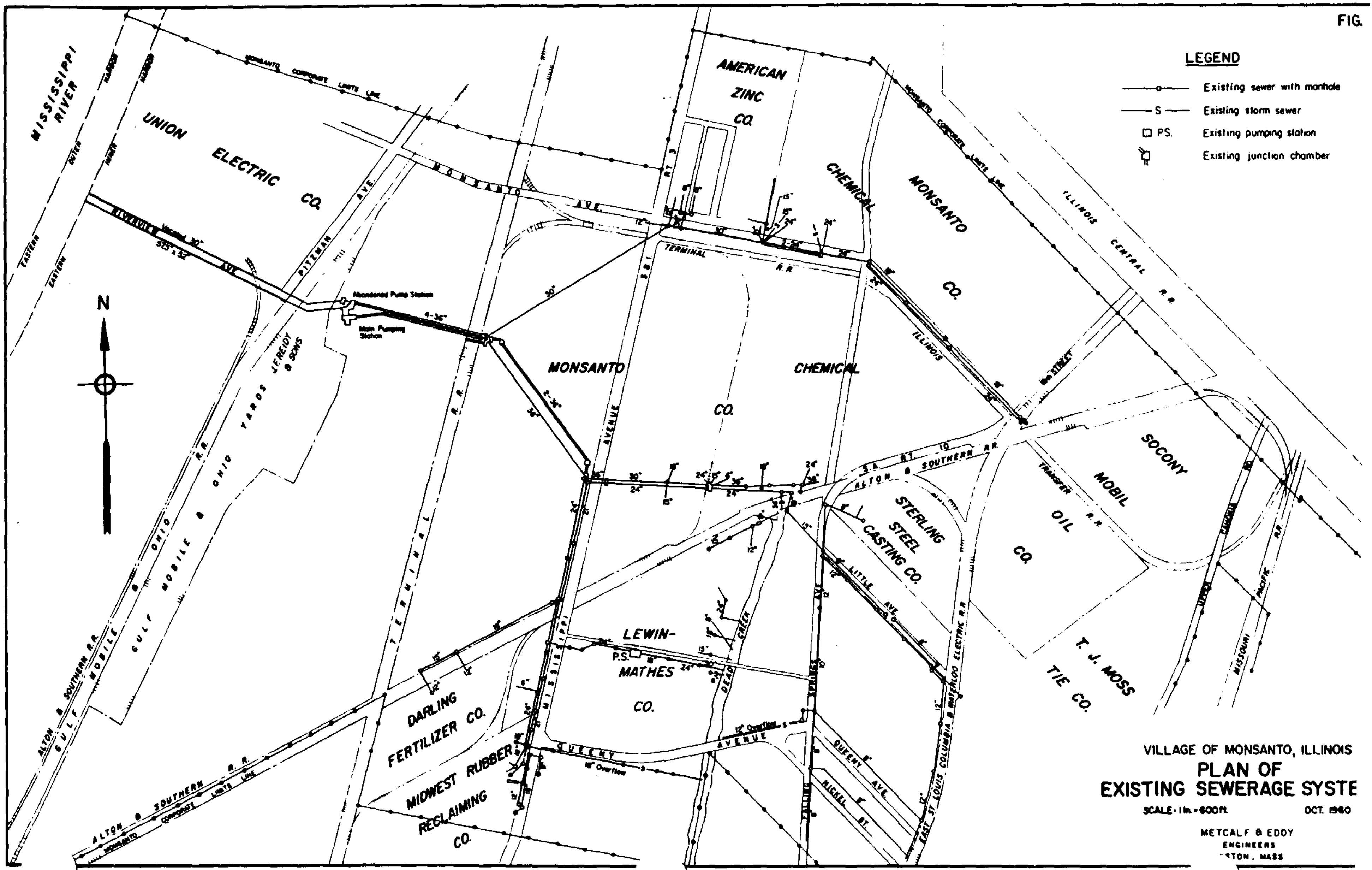


FIG.
LEGEND
Existing sewer with manhole
Existing storm sewer
PS. Existing pumping station
Existing junction chamber
N
MISSISSIPPI RIVER
UNION ELECTRIC CO.
AMERICAN ZINC CO.
MONSANTO CHEMICAL CO.
MONSANTO CORPORATE LIMITS LINE
MONSANTO AVE.
RIVERVIEW AVE.
PITZMAN AVE.
Abandoned Pump Station
Main Pumping Station
TERMINAL R.R.
ILLINOIS CENTRAL R.R.
J. F. REIDY & SONS
GULF MOBILE & OHIO YARDS
GULF MOBILE & OHIO R.R.
ALTON & SOUTHERN R.R.
MISSISSIPPI AVENUE
S.A. RT. 10
ILLINOIS
SOCONY MOBIL OIL CO.
TRANSFER R.R.
STERLING STEEL CASTING CO.
LITTLE AVE.
LEWIN-MATHES CO.
P.S.
DEAD CREEK
SPRINGS AVE.
EAST ST. LOUIS COLUMBIA & WATERLOO ELECTRIC R.R.
T. J. MOSS TIE CO.
MISSOURI PACIFIC R.R.
DARLING FERTILIZER CO.
MIDWEST RUBBER RECLAIMING CO.
QUEENY AVENUE
18" Overflow
12" Overflow
QUEENY AVE.
NICKEL ST.
VILLAGE OF MONSANTO, ILLINOIS
PLAN OF
EXISTING SEWERAGE SYSTE
SCALE: 1 in. = 600 ft.
OCT. 1960
METCALF & EDDY
ENGINEERS
BOSTON, MASS.
38125-Z-1

American Zinc Company.

The American Zinc Company obtains the majority of its water from wells and discharges its waste waters to the village sewer system through two separate sewers. They are designated as the East and West sewers. The former is 15 in. in diameter and the latter 21 in. Because of unusual conditions in the manholes giving access to the sewers, it was impractical to attempt measurement of flows in the sewers. After consultation with Mr. T.I. Moore, Plant Manager, of American Zinc Company, it was concluded that reasonably accurate estimates of the daily flow of wastes could be made and, since most operations were of a continuous nature, there was good reason to believe that the hour to hour flows were quite uniform.

Estimates of flow were made by American Zinc Company personnel and are as presented on page A-1, Appendix A. From these data we conclude that the East Sewer carries about 630,000 gallons of waste water per day and the West Sewer carries about 4,788,000 gpd. (gallons per day), or a total flow of 5.42 mgd. (million gallons per day).

Darling Fertilizer Company.

At a conference with Mr. H. L. Stangel, Division Manager, of Darling Fertilizer Company, it was ascertained that Darling Fertilizer obtains its water from the public supply and uses the majority of it for sanitary purposes. Darling has two connections to the sewer system as shown in Fig. 1. The North sewer serves the main plant and office area while the East sewer serves the lavatory and shower room for colored employees. Because of the small volume of waste waters from Darling, no attempt was made to gage the entire flow. Instead volumetric measurements were made of flow in the East sewer and water meter records were studied to obtain the total flow as shown on page A-2, Appendix A. The average water consumption for the 14-month period studied was 42,000 gpd. or 29 gpm. (gallons per minute). The average flow in the East sewer was found to be 7 gpm. Therefore, a flow of 22 gpm. was allocated to the North sewer.

Lewin Mathes Company.

The Lewin Mathes Company is served by a number of sewers and storm drains as shown in Fig. 1. Sanitary wastes and a considerable amount of processing wastes are collected in a sump and then pumped via a 24-in. sewer to a village sewer along Mississippi Avenue. This is referred to as the Mississippi Avenue sewer in the report. All other sewers serving Lewin Mathes discharge directly into Dead Creek. A 15-in. sewer serves the Control Building and other areas and is referred to as the Control Building sewer. A second 15-in. sewer serves the northeast part of the mill and wastes from this sewer, at one time, were pumped into the village system by a lift station. The lift station is no longer in operation and the wastes now discharge directly into Dead Creek. The sewer, however, is designated as the Village Lift Station sewer. Among the storm drains, one 24-in. sewer was found to carry waste processing water.

The waste waters carried by the Mississippi Avenue, Control Building and Village Lift Station sewers were all measured by use of weirs and bubbler gages. The flow in the 24-in. storm sewer was determined by several volumetric measurements.

The results of the flow measurements at Lewin Mathes are shown on pages A-3 to A-6, inclusive. A summary of the data is given on page A-6. From these data it may be concluded that instantaneous waste water flows from Lewin Mathes may vary from 1,420 to 2,500 gpm., flows during 8-hour shifts may vary from 0.79 to 1.159 mil. gal., and daily flows from 2.65 to 3.37 mgd. The average flow is expected to be about 3.0 mgd.

Midwest Rubber Company.

Midwest Rubber Company has a number of sewers and storm drains that discharge into two interconnected manholes. The manholes are served by two village sewers, one a 21 in., and the other a 24 in. In order to avoid the complications of gaging the flow in two parallel sewers, permission was obtained from Mr. H. R. Erwin, Vice President-Production, Midwest Rubber Company, to place an easily removable dam in the mouth of the 21-in. sewer and force all flow through the 24-in. sewer during the course of our survey.

The flows in the 24-in. sewer were obtained by use of a bubbler gage to obtain a continuous record of water elevation in the sewer and a lithium chloride dilution test to determine the actual flow at a particular time. From the latter it was possible to interpret the continuous bubbler gage data in terms of actual flow.

A summary of the flow data obtained is given on page A-7. These data show a remarkable uniformity. The range of instantaneous flows was 2,160 to 2,990 gpm. Flows for 8-hour shifts varied from 1.05 to 1.43 mil. gal., while daily flows varied from 3.18 to 4.17 mgd. with an average of 3.60 mgd.

Mobil Oil Company.

The majority of the process waters from Mobil Oil Company refinery pass through API separators for recovery of oil before they discharge to the village sewers. Some minor sources of process water, boiler blow-down, cooling tower blow-down, and waste water plus sludge from the water softening plant are discharged directly to the sewer.

The refinery is served by two sewers, one 18 in. and one 24 in., that drain a cluster of 4 manholes. Inspection of the sewers indicated that it would be impractical to attempt gaging the flows in the sewers.

The actual flow of waste process water was determined by operating the two API separators in series and measuring the flow over the weir in the final unit. A bubbler gage was installed to give a continuous record of the head on the weir. Operation in series gave a significant and readily measurable head on the weir at all times. The other flows of waste water reaching the sewer were estimated by Mr. George T. Snyder, Manager, Technical Division, Mobil Oil Company, and his associates. The data obtained by us and that supplied by Mobil are shown on page A-8.

During the course of the survey, flows for 8-hour shifts ranged from 740 to 1,370 gpm. or 0.35 to 0.66 mil. gal., and daily flows ranged from 1.14 to 1.82 mgd. The average flow was found to be 1.51 mgd.

Monsanto Chemical Company.

The Krummrich plant of the Monsanto Chemical Company operates in two areas, the Main Area and the North Area. The Main Area is located south of Monsanto Avenue and is served by two village sewers. One is 24 in. in diameter and the other 30 in. The two sewers are tied together near the head end by means of a 24-in. connection and flow through common junction boxes at two locations, one at about the mid-point, and the other near Mississippi Avenue.

The 24-in. sewer also receives waste water from Sterling Steel Casting Company and sanitary wastes from the southerly residential area of Monsanto Village. In addition, the 24-in. line is connected to Dead Creek through a 36-in. line. The latter serves as an overflow device at times when the village sewer system is surcharged, with Dead Creek serving as a storage reservoir. Under normal conditions, the upper reaches of Dead Creek drain into the 24-in. sewer carrying with them the waste waters from three sewers at Lewin Mathes.

In order to gage the flows from Monsanto's Main Area accurately, it was necessary to place a dam across the entrance of the connection from Dead Creek to the 24-in. sewer. It would have been desirable to have excluded the flow from Sterling Steel and adjacent areas of Monsanto Village, but that was impractical. However, the flows from those sources were considered more or less negligible in comparison to the total flow from the Monsanto Main Area.

The flow in the 30-in. sewer was determined from a record of the depth of water in the sewer as measured by a bubbler gage. The actual flow in the sewer was measured on three occasions by the lithium chloride dilution technique and from the data a rating curve for flow in the sewer was developed. This was possible because the sewer was flowing nearly full at all times and the variation in water depth was never greater than 6.4 in. and usually less than 4 in. A summary of the flows in the 30-in. sewer is shown on page A-9. These data show that the instantaneous flows varied from a minimum of 9,400 to a maximum of 10,200 gpm. The flows for 8-hour shifts varied from a low of 4.55 to a high of 4.85 mil. gal. The daily flows ranged from 13.78 to 14.34 mgd., with an average of 14.16 mgd.

The 24-in. sewer serving Monsanto Chemical Company's Main Area presented some complications in flow measurement. Bubbler gage readings showed this sewer to be slightly surcharged most of the time and, since water elevations were not available at two locations on the sewer, it was impossible to calculate the flow by conventional means. An estimate of the flow was made by hydraulic analogy with the 30-in. sewer.

It was assumed that "n" values of both sewers would be very nearly equal because of similar material and service. On the basis that both sewers were full or very nearly full at the time of gagings, their relative carrying capacities could then be determined by the ratio of certain hydraulic elements. Using Mannings' formula for flow, the ratio of these elements for the depth ranges determined by gagings averages 0.55, which is exactly their ratio with both sewers full. Accordingly, the gaged flows in the 30-in. sewer, reduced 45 percent, were used to make up the table on page A-10. One dependable instantaneous flow measurement for the 24-in. sewer was made by the lithium chloride technique. The flow rate determined, 7.49 mgd. was in good agreement with the tabulated values determined by the ratio method. On the basis of these data, the flow per 8-hour shift in the 24-in. sewer varied from 2.5 to 2.66 mil. gal. and the daily flow ranged from 7.57 to 7.88 mgd., with an average of 7.79 mgd.

The North Area of Monsanto Chemical Company is served by two main sewers and two storm sewers. These are designated as the East Main, East Storm, West Main, and West Storm sewers.

The flows in the East Main and West Main sewers were measured by means of bubbler gage records of the water elevation in the sewers. Determination of an instantaneous flow by the lithium chloride dilution technique allowed calculation of the "n" value of the sewer. Since the size and slopes of the sewers were known, it was then possible to translate the bubbler gage data into flows.

The flow data for the East Main Sewer is given on page A-11 and shows instantaneous flows to vary from 660 to 1,398 gpm. The 8-hour shift flows varied from 0.334 to 0.465 mil. gal. and the daily flows ranged from 1.02 to 1.35 mgd.

The flows in the West Main sewer are presented on page A-12. Instantaneous flows varied from 704 to 816 gpm. and flows for 8-hour shifts ranged from 0.342 to 0.382 mil. gal. The daily flows ranged from 1.07 to 1.13 mgd. and averaged 1.10 mgd.

The West Storm sewer was found to carry a considerable amount of waste water at all times. The flow in this sewer was measured by means of a weir and a bubbler gage that recorded the head on the weir, continuously. The flows are shown on page A-13. The instantaneous flow ranged from 20 to 360 gpm. and the 8-hour shift flows varied from 0.012 to 0.156 mil. gal. The minimum daily flow was 0.115 mgd. and the maximum 0.398 mgd. The average flow was 0.260 mgd.

The flow of waste water in the East Storm sewer was not gaged because of the small flow which was estimated to be 40 gpm.

A summary of the waste flow data for Monsanto Chemical Company is presented on page A-14. These data show that flows are extremely uniform. The instantaneous flows showed a variation of 10,800 to 12,800 gpm., flows for 8-hour shifts ranged from 7.73 to 8.52 mil. gal., and daily flows varied from 23.56 to 25.10 mgd., with an average of 24.6 mgd.

Sterling Steel Casting Company.

The waste water flows from Sterling Steel Company were not gaged. At a conference with Messrs. Charles and John Shive of Sterling Steel, it was established that no water was used in processing steel and that the only waste waters were those used for sanitary purposes and for air conditioning during about 20 weeks of the year.

Sterling Steel obtains its water for sanitary purposes from the public water supply. A study of water records from May 1959 through October 1959 showed the daily consumption to vary from 5,420 to 9,410 gpd., with an average of 7,710 gpd. The employees of Sterling Steel approximate 325. Water usage for sanitary purposes averaged 34 gpd. per employee, a reasonable figure. Well water is used at the rate of 150 gpm. for air conditioning purposes for about 10 hours per day, 5 days each week for a period of approximately 20 weeks. It is concluded, therefore, that the waste water flow will approximate about 100,000 gpd. for about 20 weeks during the summer and 8,000 gpd. for the remainder of the year.

Other Sources of Waste Waters.

In addition to the sources of waste waters listed above, the domestic wastes from the residents of Monsanto Village, totaling about 350 people are discharged to the sewer system. It is estimated that this represents about 35,000 gpd.

The T. J. Moss Tie Company, Joseph F. Reidy & Sons, and Union Electric Company are other industries located in Monsanto Village which do not have connections to the existing sewer system and there is no apparent desire on the part of any of them to seek sewer connections in the immediate future. For this reason, no attempt was made to study their waste disposal problems.

Total Waste Flows for Monsanto Village.

A summary of the total waste water flows from Monsanto Village is presented in Table 1. These data show that the average flow was 38.2 mgd. and that minimum and maximum daily flows were 36.04 and 39.9 mgd., respectively. From this it may be concluded that the daily variation in flow can be expected to vary less than ± 5 percent of the average flow. The 8-hour shift flows ranged from 11.76 to 13.59 mil. gal. and averaged 12.72 mil. gal. This would indicate that flows over 8-hour periods would vary less than ± 8 percent.

In view of the fact that the wastes of Monsanto Village contain phenol bearing and metal bearing wastes, as will be shown later, it was necessary to consider the volumes of each type of waste separately so that the feasibility of separate treatment could be determined. A study of the sewer system in relation to the various industries showed that segregation of the wastes could be accomplished at reasonable cost.

The volume of the phenol bearing and metal bearing wastes is shown in Table 2. The wastes from Sterling Steel and some of the domestic wastes are included with the

Table 1. Total Waste Water Flows

Monsanto Village

	8-Hour Shifts, Mil. Gal.			Total, Mgd.		
	Min.	Max.	Av.	Min.	Max.	Av.
American Zinc	1.80	1.80	1.80	5.42	5.42	5.42
Darling Fertilizer	0.01	0.01	0.01	0.04	0.04	0.04
Lewin Mathes	0.79	1.16	1.00	2.65	3.37	2.98
Midwest Rubber	1.05	1.43	1.20	3.18	4.17	3.60
Mobil Oil	0.37	0.66	0.50	1.14	1.66	1.51
Monsanto Chemical	7.73	8.52	8.20	23.56	25.10	24.60
Sterling Steel	--	--	--	0.01	0.10	0.01
Other	0.01	0.01	0.01	0.04	0.04	0.04
Totals	11.76	13.59	12.72	36.04	39.90	38.20

Table 2. Volume of Waste Water Flows
Classified as to Type

	Mgd.	Total, mgd.
<u>Phenol Bearing Wastes</u>		
Mobil Oil Company	1.51	
Monsanto Chemical Company	24.60	
Sterling Steel Casting Co.*	0.01	
Others*	0.04	26.16
<u>Metal Bearing Wastes</u>		
American Zinc Company	5.42	
Darling Fertilizer Company*	0.04	
Lewin Mathes Company	2.98	
Midwest Rubber Company	3.60	12.04
	Grand Total	38.20

*These wastes included in the particular class because of their location on the sewer system.

phenol-bearing wastes because their location on the sewer system and the amount of wastes does not justify other handling. The total volume of phenol bearing wastes is expected to be 26 mgd. and the amount of metal bearing wastes 12 mgd.

Because a number of the industries discharge large amounts of cooling water to the sewer, it was deemed advisable to determine how much conservation practices might be expected to reduce the volumes of wastes from each of the industries. In addition, an attempt was made to gain information from each industry relative to the flow of wastes to be expected in 1965, 1970 and 1980. On the basis of discussions and correspondence, we conclude that the American Zinc Company and Midwest Rubber Company can accomplish significant reductions in waste water volumes and are awaiting reasonably firm estimates of the savings in waste treatment costs before embarking upon a program of water conservation.

Estimates of waste water flows for the future are given in Table 3. From this information, we conclude that water conservation practices will have little effect on the volume of phenol-bearing wastes other than to hold them near the present levels. This indicates that design for present flows will be adequate for at least 20 years.

WARBURG RESPIROMETER STUDIES

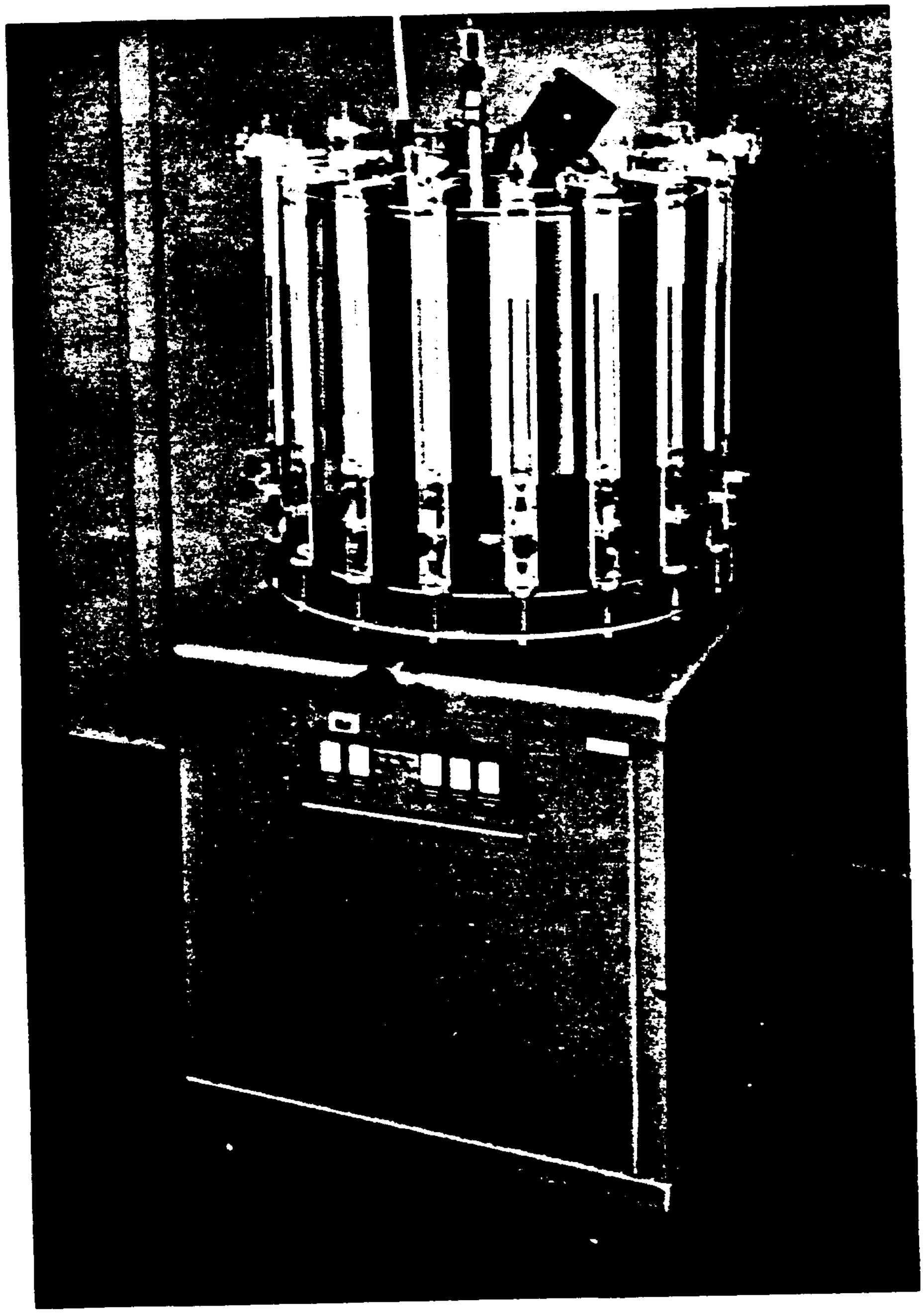
Because of the fact that the waste waters of Monsanto Village contain appreciable amounts of phenols, it seemed likely that some form of biological treatment would be required to accomplish their destruction. Toxic materials are a consideration in the operation of any biological treatment process. Therefore, all the 8-hour composited samples, and grab samples taken in lieu of them, were submitted to test in the Warburg Respirometer, the purpose being to determine which waste streams might require isolation and detoxification before admission to the sewer system.

The Warburg Respirometer is shown in Fig. 2. It consists essentially of a series of systems maintained under constant temperature conditions and connected to manometers open to the atmosphere. The procedure used was to bring each waste into contact with an activated sludge (acclimated to phenol) in the closed systems and note the rate and amount of oxygen used from changes in the manometer readings. When compared to control systems containing activated sludge alone, a measure of the toxicity was possible.

American Zinc Company Wastes.

Most of the samples of waste waters from the American Zinc Company showed some evidence of toxicity when the wastes were present in an amount corresponding to 50 percent of the total mixture. The toxicity was considerably less at the

FIG. 2



A WARBURG RESPIROMETER

25 percent level. Since American Zinc Company wastes represent only 15 percent of the total Monsanto Village waste flow, it was concluded that they, by themselves, would not be so detrimental to biological processes as to merit pretreatment before discharge to the sewer.

Darling Fertilizer Company Wastes.

The waste waters from Darling Fertilizer Company were found to be somewhat toxic at the 50 percent concentration level. Because of the small volume involved, the wastes were considered acceptable.

Lewin Mathes Company Wastes.

Most of the samples from Lewin Mathes showed toxic properties, particularly samples from the Control Building sewer. The toxicity was usually considerably less at the 25 percent level than at the 50 percent level. Because Lewin Mathes Company waste waters represent only 8 percent of the total waste flow of Monsanto Village, it was concluded that they, by themselves, would not be so detrimental to biological processes as to merit pretreatment before discharge to the sewer.

Midwest Rubber Company Wastes.

Some evidence of toxicity was found in certain samples of Midwest Rubber Company wastes at the 50 percent level but none at the 25 percent level. Since the Midwest wastes represent only 11 percent of the total Monsanto Village waste water flow, it was concluded that the wastes were essentially nontoxic.

Mobil Oil Company Wastes.

The studies with Mobil Oil Company waste waters at 25 and 50 percent concentrations showed no evidence of toxicity.

Monsanto Chemical Company Wastes.

A total of 65 samples representing 63 shift samples and two grab samples were subjected to toxicity study in the Warburg Respirometer. The data obtained are summarized in Table 4.

Table 4. Summary of Toxicity Studies Upon Monsanto Chemical Company Waste Waters (By Warburg Respirometer)

Source	Number of Samples	Toxic at Concentrations of 25%		50%	
		No	Yes	No	Yes
Main Area					
24-In. Sewer	12	11	1	10	2
30-In. Sewer	14	14	0	13	1
North Area					
East Main	14	14	0	11	3
East Storm	2	2	0	2	0
West Main	12	8	4	6	6
West Storm	11	2	9	1	10

These data show that the Monsanto Chemical Company waste waters with the exception of those carried in the West Main and West Storm sewers are relatively free of substances toxic to an activated sludge acclimated to phenols. The wastes from the West Main and West Storm sewers, particularly the latter, were quite toxic. The flow in these sewers, however, is less than 4 percent of the total Monsanto Village waste flow, consequently it was concluded that dilution provided by other wastes would eliminate any toxic effects.

Sterling Steel Company Wastes.

The analytical data obtained on Sterling Steel Company wastes demonstrated that they were comparable to domestic sewage, therefore no toxicity studies were made.

CONTRIBUTIONS OF POLLUTANTS BY SPECIFIC INDUSTRIES

In the consideration of any waste treatment problem, the factors of volume and concentration of pollutants must be taken into account. This is particularly true where industrial wastes of widely varying character and strengths are involved. The most practical means of combining the factors of flow and concentration is to express the contributions in terms of pounds or tons per day. The items of volume and amount of pollutants normally serve as an equitable basis of charges for waste treatment.

During the course of the survey at Monsanto Village, it became apparent that the pollutants of concern were:

1. Acidity
2. Suspended Solids
3. BOD
4. Phenols
5. Copper
6. Zinc

It also became apparent on the basis of the methods of treatment recommended that BOD was not a consideration in the metal-bearing wastes.

The minimum, maximum, and average daily contributions of pollutants contributed to the Monsanto Village sewer system from each major sewer and from each industry are shown in Appendix C, pages C-1 to C-18.

American Zinc Company.

A summary of the contributions of pollutants from the two sewers serving the American Zinc Company is shown on page

C-3. It will be noted that the majority of the suspended solids are contained in flow from the West sewer while the major part of the zinc is carried in the flow from the East sewer. The contributions of copper from both sewers are very nominal.

Darling Fertilizer Company.

The contributions from Darling Fertilizer Company are mainly suspended solids and BOD of minor amounts and are presented on page C-4.

Lewin Mathes Company.

A summary of the contributions of pollutants from the three major sewers serving Lewin Mathes Company is given on page C-8. The contributions from the 24-in. Storm sewer were considered insignificant in comparison to the total and were not included.

The data on page C-8 show that each of the sewers at Lewin Mathes contribute about equal amounts of suspended solids. The Control Building sewer contributes the large majority of the copper and zinc.

Midwest Rubber Company.

The contribution of important pollutants from the Midwest Rubber Company are given on page C-9. Midwest is a major contributor of suspended solids, BOD and zinc.

Mobil Oil Company.

The pollutants of concern contributed by the Mobil Oil Company are suspended solids, BOD and phenols as shown on page C-10. Because of the considerable amount of $CaCO_3$ contained in the suspended solids contributed by Mobil Oil and their beneficial effects in the sewer in aiding in the neutralization of mineral acids contributed by other industries, "corrected" suspended solids values based upon volatile suspended solids were used to obtain the amount of pollutional suspended solids contributed by Mobil Oil. The formula used for calculation was:

$$\frac{\text{Volatile suspended solids, mg./L}}{0.75} = \text{Suspended Solids, mg./L.}$$

The BOD and phenol values shown on page C-10 are the actual values as determined. Following changes in plant operation designed to eliminate the discharge of certain phenol bearing wastes from the sewer, a resurvey of the wastes discharged by Mobil Oil showed a marked reduction in concentrations. The adjusted values based upon this new information are also shown on page C-10.

Monsanto Chemical Company.

The major pollutants in Monsanto Chemical Company waste waters are mineral acidity, suspended solids, BOD and phenol. Since treatment of Monsanto wastes for phenol destruction by biological means will require neutralization of the wastes to about pH 8, total acidity values have been substituted for mineral acidity.

A summary of the pollutants contributed by the six sewers serving Monsanto Chemical Company is shown on page C-17 and 18. These data show that the majority of the total acidity, BOD and phenol are contributed by the waste flows in the 24-in. and 30-in. sewers serving the Main Area. However, the West Main sewer in the North Area carries wastes that contribute over 50 percent of the suspended solids.

Total Contributions of Pollutants to Monsanto Village Sewer System.

The contributions of pollutants to the Monsanto Village sewer system are shown in Table 5, pages 41 and 42. These data show that the only contributor of mineral acidity is Monsanto Chemical Company and that the total acid characteristics of their wastes are equivalent to about 125,000 lb. or 62.5 tons of calcium carbonate ($CaCO_3$) per day.

Monsanto Chemical and Midwest Rubber are major contributors of suspended solids, with American Zinc and Mobil Oil contributing significant amounts.

The majority of the BOD load is contributed by Monsanto Chemical while Midwest Rubber and Mobil Oil add significant amounts.

Phenolic materials are contributed almost entirely by Monsanto Chemical and Mobil Oil, the former supplying by far the greater amount.

Table 5. Total Daily Contributions of Pollutants to Monsanto Village Sewer System (Lb.)

	Total Acidity			Suspended Solids		
	Max.	Min.	Av.	Max.	Min.	Av.
American Zinc	--	--	--	6,600	2,180	3,685
Darling Fertilizer	--	--	--	195	135	160
Lewin Mathes	--	--	--	2,300	1,140	1,610
Midwest Rubber	--	--	--	18,600	7,940	12,640
Mobil Oil	--	--	--	5,540	2,840	3,940
Monsanto Chemical	175,400	84,600	125,100	17,820	7,110	12,070
Sterling Steel	--	--	--	--	--	30
Other	--	--	--	--	--	90
Totals, lb./day	175,400	84,600	125,100	51,100	21,400	34,200

Table 5 (cont.). Total Daily Contributions of Pollutants to Monsanto Village Sewer System (Lb.)

	BOD			Phenol		
	Max.	Min.	Av.	Max.	Min.	Av.
American Zinc	140*	120*	130*	--	--	--
Darling Fertilizer	30*	10*	15*	--	--	--
Lewin Mathes	710	430	530	--	--	--
Midwest Rubber	11,875	1,985	5,460	--	--	--
Mobil Oil	10,480	2,245	5,040 3,700**	2,565 500**	375	1,050 350**
Monsanto Chemical	37,300	21,000	30,200	11,400	4,100	8,200
Sterling Steel	--	--	20	--	--	--
Other	70	70	70	--	--	--
Totals, lb./day	59,900	25,400	41,700 (40,400)**	13,965 (11,900)**	4,475	9,250 (8,550)**

* Estimated from number of employees because of toxicity of wastes.
** Estimated values based on resurvey at Mobil Oil following changes in plant operation.

Table 5 (cont.). Total Daily Contributions of Pollutants to Monsanto Village Sewer System (lb.)

Phenol-Acid Bearing Wastes

	Total Acidity		Suspended Solids		B.O.D.		Phenol	
	Max.	Av.	Max.	Av.	Max.	Av.	Max.	Av.
Mobil Oil	--	--	5,540	3,940	10,480	5,040 (3,700)*	2,565 (500)*	1,050 (350)*
Monsanto Chemical	175,400	125,100	17,820	12,070	37,300	30,200	11,400	8,200
Sterling Steel	--	--	--	30	--	20	--	--
Other	--	--	--	90	--	70	--	--
Totals	175,400	125,100	23,000	16,100	47,800	35,200 (32,800)*	14,000 (11,900)*	9,250 (8,550)*

* Revised values based on phenol levels in waste following changes in plant operation.

Table 5 (cont.). Total Daily Contributions of Pollutants to Monsanto Village Sewer System (lb.)

Metal Bearing Wastes

	Suspended Solids		Copper		Zinc	
	Max.	Av.	Max.	Av.	Max.	Av.
American Zinc.	6,600	3,685	--	—	1,920	1,455
Darling Fertilizer	210	170	--	--	--	--
Lewin-Mathes	2,300	1,610	803	455	675	424
Midwest Rubber	18,600	12,640	--	--	1,215	990
Totals, lb./day	27,700	18,100	803	455	3,810	2,870

CONSIDERATION OF METHODS OF TREATING MONSANTO VILLAGE WASTE WATERS

The major objective in treating the wastes from the Village of Monsanto is to remove floating matter, settleable solids and phenolic materials. The first two can be accomplished by means of sedimentation basins where the velocity of movement is restricted sufficiently to allow floatable matter to rise to the surface, so that it can be skimmed off; at the same time the heavy solids will settle under the influence of gravity and can be removed from the bottom of the basin. The phenolic materials, however, are normally in solution and do not separate from the liquid. This requires that they be removed by some other means. For the concentrations involved in Monsanto Village wastes, the only practical method is by employing biological treatment methods, either trickling filters or the activated sludge process.

Consideration was given to employing trickling filters or activated sludge. Since copper, chromium and zinc are somewhat detrimental to the operation of biological treatment processes, a study was made of the capital and operating costs for treating only the phenol bearing wastes as well as the combined wastes by both the activated sludge and trickling filter methods. The results of this study are given in Table 6. These estimates show that there is a definite capital cost saving by employing the activated sludge process. At least two other factors would prompt selection of the activated

TABLE 6. COMPARISON OF ESTIMATED CAPITAL AND ANNUAL COSTS FOR VARIOUS PLANS OF WASTE WATER TREATMENT

Item	Estimated Capital Costs				
	Activated Sludge			Trickling Filters	
	Plan I	Plan II	Plan III	Plan IV	Plan V
Total Estimated Const. Cost	$4,740,000	$4,400,000	$4,194,000	$6,286,000	$4,964,000
Total Estimated Capital Cost*	6,658,000	6,238,000	5,978,000	8,569,000	6,929,000
	Estimated Annual Costs				
Total Estimated Annual Cost**	$1,095,000	$1,015,500	$988,000	$1,139,500	$991,500

Plan I: One Activated Sludge Treatment Plant for 38 mgd. - sludge lagooned.

Plan II: One Primary Treatment Plant for 12 mgd. - sludge lagooned; and one Activated Sludge Treatment Plant for 26 mgd. - sludge lagooned.

Plan III: One Primary Treatment Plant for 12 mgd. - sludge lagooned; and one Activated Sludge Treatment Plant for 26 mgd. - waste activated sludge to river.

Plan IV: One Trickling Filter Treatment Plant for 38 mgd. - sludge lagooned.

Plan V: One Primary Treatment Plant for 12 mgd. - sludge lagooned; and one Trickling Filter Treatment Plant for 26 mgd. - humus sludge to river.

* Includes estimated construction cost; allowance for construction contingencies; allowances for engineering, administrative, legal, and fiscal costs; and the purchase of land and special equipment.

** Includes debt service for $2,500,000 of General Obligation Bonds and the remainder in Revenue Bonds; estimated labor, maintenance, chemicals, and power costs; and allowances for administrative, fiscal and insurance costs.

sludge method. The first is temperature control. Biological processes are influenced greatly by temperature. Trickling filters act as cooling towers and under winter conditions, particularly when recirculation is practiced, the temperature drop could be serious enough to reduce phenol removals. Low flows are usually encountered in the Mississippi River during the coldest part of the winter. Thus, when the need for phenol removals is the greatest, trickling filters would be least likely to meet the requirements of the river. Second, the character of the combined wastes of Monsanto Village varies considerably over relatively short periods of time. Trickling filters provide very little storage of water and, consequently, little opportunity for dilution. The latter is of considerable concern where toxic substances are present in varying amounts. It was concluded, therefore, that trickling filters, in addition to being more expensive, would be less reliable in producing a low phenol content effluent. For these reasons further consideration was not given to trickling filter treatment.

Because of the presence of considerable amounts of copper and zinc in the combined wastes of Monsanto Village and the relatively small cost at which the wastes of the Village might be segregated into two streams, one containing the principal metal bearing wastes and one containing all the phenol wastes, a study employing the activated sludge process was initiated to determine the benefits that might be derived from treating the phenol bearing wastes alone versus the combined wastes.

ACTIVATED SLUDGE STUDIES

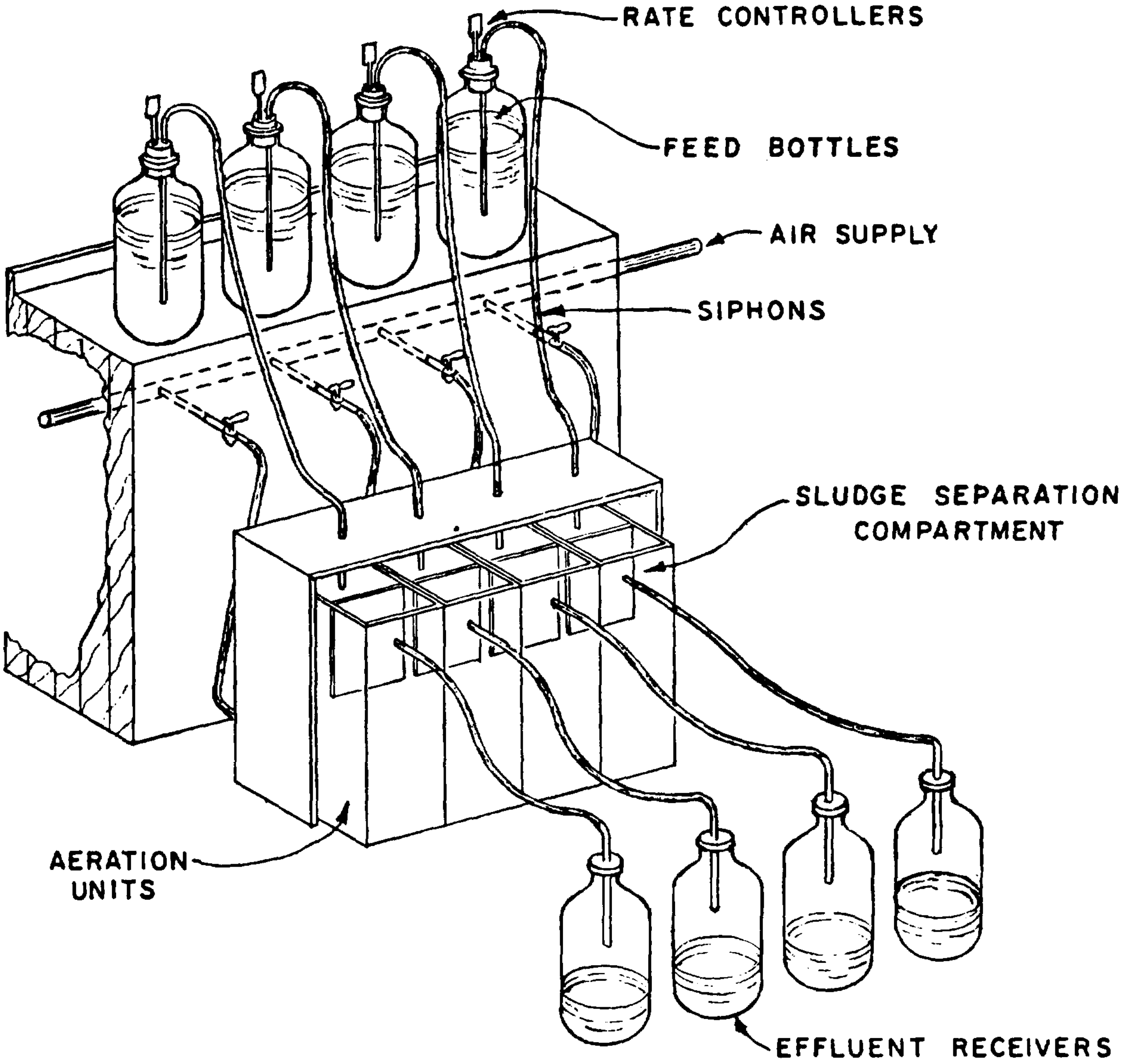
The activated sludge studies were conducted in laboratory scale continuous flow type of equipment at the laboratory of Monsanto Chemical Company. A schematic diagram showing a battery of four units is given in Fig. 3.

Eight units were operated in parallel and the experiment was designed to evaluate: (1) the treatability of phenol-bearing wastes alone versus the combined wastes, and (2) the need for removing floc formed by neutralization of the wastes with lime. The studies were conducted at two different detention times, 5-6 hours and 10-12 hours. The effectiveness of treatment was determined solely by phenol levels in the final effluent, since BOD is not a major consideration in the Mississippi River. Because of the interrelationship between BOD and phenolic materials, it may be concluded that good phenol removals would be accompanied by good BOD removals.

The combined Monsanto Village wastes for the activated sludge studies were obtained by hand sampling the wastes hourly over a 6-hour period each day. The wastes were neutralized with lime to a pH in the range of 7.5 - 8.5 before feeding to the units.

Collection of samples representative of the phenol-bearing wastes required establishing sampling stations on all the sewers draining from Monsanto Chemical Company in addition

FIG. 3



BATTERY OF CONTINUOUS FLOW ACTIVATED SLUDGE UNITS to the sewers serving Mobil Oil Company. Samples were collected hourly over a 6-hour period each day and composited according to flow data previously obtained on each sewer. The wastes were neutralized with lime to a pH between 7.5 and 8.5 before feeding to the activated sludge units.

Samples of the Monsanto Village combined wastes and Mobil-Monsanto combined wastes were forwarded to our Boston laboratory for analysis. The results are shown in Appendix B, pages B-38 to B-47, inclusive.

Character of Monsanto Village Combined Wastes and Mobil-Monsanto Wastes.

A total of thirty 6-hour composited samples of Monsanto Village combined wastes were collected over the period of June 21, 1960 to July 23, 1960. A similar number were collected from sewers carrying phenol wastes during the same period. The details of the analytical data obtained are given in Appendix B, pages B-38 to B-47, inclusive.

A summary of the analytical data is presented in Table 7. The following comments are considered significant in terms of treatment of the wastes by activated sludge.

pH - The samples of combined wastes from Monsanto Village varied from pH 1.9 to 7.8 while those from Mobil-Monsanto Chemical varied from 1.9 to 10.4. This indicates that pH control will be needed on both wastes. It also indicates that the pH of Mobil Monsanto wastes on occasion may be too high and suggests the need for emergency storage or equalization.

Table 7. Comparison of Chemical Character of Monsanto Village Combined Wastes versus Mobil-Monsanto Chemical Company Wastes (30 6-Hour Composited Samples)

	Monsanto Village		Mobil-Monsanto	
	Range	Av.	Range	Av.
pH	1.9-7.8	---	1.9-10.4	---
Acidity-Mineral	0-2500	363	0-1900	510
Acidity-Total	0-2900	600	0-2100	725
Alkalinity	0-570	---	0-950	---
Suspended Solids	83-4410	470	14-690	126
Total Solids	2210-8280	3390	2430-5790	3800
Bod - 5-day	130-660	270	105-765	295
10-day	155-645	335	155-730	340
COD	535-5540	1370	525-4490	1000
Copper	0.5-9.0	2.0	0.2-3.0	1.1
Zinc	1.5-128	21.0	0.2-10.0	2.9
Phenol	14-72	31.7	17-196	44
Nitrogen	5-71	25.5	9-96	24
Phosphorus	4.6-31	12.0	3.3-47	12.5

All values in milligrams per liter, except pH.

Mineral and Total Acidity - The combined wastes of Monsanto Village and from Mobil-Monsanto Chemical contained appreciable amounts of mineral acidity. Total acidity, however, is more important with respect to activated sludge treatment, since it represents a measure of the lime required to neutralize the wastes to an acceptable level for biological treatment. It will be noted that the average total acidity of the Monsanto Village wastes was 600 mg./L while that of the Mobil-Monsanto Chemical wastes was 725. When flows are considered and corrections are made for the percentage of time that the wastes contain mineral acidity, the lime requirements, expressed as calcium hydroxide $Ca(OH)_2$, were found to be 53 tons per day for the combined Monsanto Village wastes and 51 tons per day for the Mobil-Monsanto Chemical wastes. Detailed calculations are shown in Appendix D, pages D-1 and D-2.

Suspended Solids - Suspended solids were found to vary widely in both wastes, particularly those from the Monsanto Village combined wastes. This demonstrates the need for primary sedimentation tanks, preceding activated sludge treatment units.

BOD - The 5-day BOD and 10-day BOD values were not significantly different for the two wastes. This demonstrates that aeration tank capacity requirements are in direct relationship to the volume of wastes to be treated. The 5-day BOD was found to be 81 percent of the 10-day BOD in the case of Monsanto Village wastes and 87 percent of the 10-day BOD in the case of the Mobil-Monsanto Chemical wastes. This demonstrates that the wastes exert their BOD in a normal manner and are, therefore, subject to treatment by relatively short term aeration periods.

COD - The COD value in itself yields little information other than the fact that the wastes are relatively rich in organic materials. A comparison of BOD and COD data, however, does indicate that approximately 75 percent of the organic matter contained in Monsanto Village wastes is biologically inert, while only 66 percent of the organic matter in Mobil-Monsanto wastes is biologically inert.

Copper and Zinc - The copper content of Monsanto Village wastes was found to vary from 0.5 to 9.0 mg./L and the Mobil-Monsanto wastes from 0.2 to 3.0 mg./L. The zinc content of the wastes was found to range from 1.5 to 128 and 0.2 to 10.0 mg./L, respectively. These data show that much smaller amounts of copper and zinc are present in the Mobil-Monsanto wastes and extreme fluctuations do not occur. This would indicate that biological treatment processes could be more easily maintained on the Mobil-Monsanto wastes.

Phenol - The phenol concentration was found to range from 14 to 72 mg./L in the Monsanto Village wastes and from 17 to 196 mg./L in the Mobil-Monsanto wastes. Such variations would be intolerable in activated sludge plants of conventional design. By employing the principle of complete mixing, however, treatment of such wastes becomes possible.

Nitrogen and Phosphorus - It is generally accepted that a 5-day BOD to nitrogen ratio of 20 to 1, or less, and a 5-day BOD to phosphorus ratio of 100 to 1, or less, are optimum for biological treatment processes. The nitrogen in Monsanto Village and Mobil-Monsanto Chemical wastes is sufficient to provide a BOD to nitrogen ratio of at least 12 to 1 and the phosphorus is sufficient to provide a BOD to phosphorus ratio of at least 24 to 1. From these values, we conclude that nitrogen and phosphorus are present in great abundance.

Results of Activated Sludge Studies.

Prior to starting the continuous flow activated sludge studies, activated sludges were developed on Monsanto Village and on Mobil-Monsanto Chemical wastes by batch feeding procedures.

The continuous flow, laboratory scale activated sludge units, as shown in Fig. 3, were started in operation on June 21, 1960. Four units were inoculated with activated sludge developed from Monsanto Village wastes and four with activated sludge developed on Mobil-Monsanto wastes. The units were then fed neutralized wastes from the respective source as follows:

Monsanto Village Combined	Mobil-Monsanto Chemical
10-12 Hour Aeration Period	
1. Neutralized-unclarified	do
2. Neutralized-clarified	do
5-6 Hour Aeration Period	
3. Neutralized-unclarified	do
4. Neutralized-clarified	do

Operation of all eight units continued without interruption from June 23 through July 26, 1960, a total of 34 days. During this time it was determined that the wastes from either source could be effectively treated for phenol removal with a 5-6 hour aeration period. A summary of the results obtained during the last 16 days of the study are presented in Table 8.

The data in Table 8 show conclusively that phenol removal by activated sludge is favored materially by allowing the flocculant material formed on neutralization of the wastes to pass on into the aeration tanks. Thus, clarification following neutralization is not required. This was found to be the case for both wastes. Although it had been feared that removal of phenolic compounds might be restricted to some extent by the considerable amounts of copper and zinc in the Monsanto Village combined wastes, the laboratory studies showed that essentially as good removals were obtained in the Monsanto Village wastes as in the Mobil-Monsanto Chemical wastes. The

Table 8. Activated Sludge Studies
Phenol Removal from Monsanto Village and Mobil-Monsanto Wastes
(5-6 Hour Aeration)

Date	Monsanto Village Combined				Mobil-Monsanto Chemical			
		Effluent				Effluent		
	Feed	Unclar. Feed	Clar. Feed	% Removal	Feed	Unclar. Feed	Clar. Feed	% Removal
7/11/60	25	4.1	5.8		26	0.4	1.1	
12	33	2.8	2.1		39	1.2	2.1	
13	44	2.4	2.8		70	2.0	3.3	
14	29	3.4	3.7		23	0.7	0.5	
15	23	1.0	1.5		30	0.5	0.6	
16	40	1.0	1.7		28	3.2	1.6	
17	41	1.0	1.7		38	1.0	0.7	
18	17	0.9	2.0		17	0.8	1.1	
19	31	0.8	2.8		29	0.6	1.2	
20	22	0.8	1.0		40	1.7	1.9	
21	72	1.2	1.7		36	1.0	0.8	
22	53	1.1	1.2		55	1.1	1.3	
23	25	0.7	1.0		43	0.8	1.1	
24	51	0.5	0.8		59	0.6	1.0	
25	40	0.4	0.9		196	4.0	13.3	
26	30	0.3	0.7		58	1.0	1.5	
Av.	36	1.4	2.0	96-94	49	1.3	2.1	97-95

All results in terms of phenol, mg./L.

decision of whether to treat the total combined Monsanto Village waste flow for removal of phenol or only the Mobil-Monsanto Chemical wastes, therefore, had to be based on other considerations.

It was concluded from these studies that a 5 to 6 hour aeration period would be adequate. This was supported in a strong fashion by the results obtained with the Mobil-Monsanto Chemical wastes on July 25 and 26. On July 25 the feed to the units contained 196 mg./L of phenol. The effluent during that day contained only 4.0 mg./L. On the next day the feed contained 58 mg./L and the effluent 1.0 mg./L, indicating complete recovery of purification capacity.

It was considered impractical to study aeration periods shorter than 5 to 6 hours because of the relatively high BOD of the waste and the need for some form of equalization of the wastes, on account of their variability in character.

Excess Activated Sludge - In the operation of activated sludge units, excess sludge resulting from its growth must be wasted more or less on a continuous basis in order to keep the process in balance. Disposal of such excess sludge is a consideration that must be kept in mind in the planning of waste treatment facilities.

During the course of the activated sludge studies, records were kept of the amount of sludge that was wasted. The data obtained indicated that considerably greater amounts of sludge had to be wasted when treating the combined wastes from Monsanto Village than when treating wastes from Mobil-Monsanto Chemical.. The amount of waste activated sludge was estimated to be as follows:

<u>Monsanto Village Combined Wastes</u>

Total waste flow - 38 mgd.

Volume of waste activated sludge 0.4% of total flow, 38 x 0.004 = $\sim$150,000 gpd.

<u>Mobil-Monsanto Chemical Wastes</u>

Total waste flow - 26 mgd.

Volume of waste activated sludge 0.2% of total flow, 26 x 0.002 = $\sim$ 50,000 gpd.

From these estimates, it was concluded that treatment of the combined Monsanto Village wastes by activated sludge would produce about 150,000 gpd. of waste sludge while corresponding treatment of Mobil-Monsanto wastes would produce only 50,000 gpd. Since activated sludges are notorious because of the difficulty encountered in dewatering them for ultimate disposal, the smaller volume to be handled in the second case was further argument for segregation of Monsanto Village wastes into two streams, the metal bearing and the phenol bearing.

METAL BEARING WASTES

In view of the fact that the activated sludge studies had provided substantial evidence to indicate the desirability of segregating the metal bearing wastes from the phenol bearing wastes, it was necessary to obtain information on the behavior of the former when segregated for separate treatment. To this end, the wastes from American Zinc Company, Lewin Mathes Company, and Midwest Rubber Company were sampled at hourly intervals, over 5-hour periods, on August 4 and 5, 1960. The samples collected from each sewer were composited into one sample each day in accordance with flow data previously obtained. The combined wastes were subjected to simple flotation and sedimentation for one hour as collected and with the pH raised to 9.0 with lime. Samples of the raw wastes and settled wastes were subjected to limited analysis. Sludge volumes were measured after 1 hour and 18 hours settling. The analytical and sludge volume data are given in Table 9.

The data in Table 9 indicate that the combined metal bearing wastes will have a normal pH in the range of 6 to 7 and that simple sedimentation will reduce the suspended solids to less than 50 mg./L. Sedimentation will have little effect on the zinc content of the wastes but will reduce the level of copper somewhat. Sludge volume will approximate 0.4 percent of the total waste flow or about 50,000 gpd. for the anticipated 12 mgd. flow.

Table 9. Metal Bearing Wastes
Chemical Character and Sludge Volumes

	Raw Wastes 8/5	Settled Wastes 8/4	Settled Wastes 8/5	Lime Treated Settled Wastes 8/4	Lime Treated Settled Wastes 8/5
pH	6.9	6.9	6.9	9.0	9.0
Alkalinity*	250	200	235	50	65
Suspended Solids*	178	28	47	16	36
BOD*	14	4	11	17	24
Zinc as Zn*	30	30	25	2.0	2.3
Copper as Cu*	5.2	2.9	3.5	0.3	0.5
		Composite		Composite	
Sludge Volume, %					
1 Hr.		0.55		0.83	
18 Hr.		0.38		0.79	
Assumed		0.42		0.80	

*mg./L — Estimated sludge volume 12 mgd.x 0.0042 = ~ 50,000 gpd.
12 mgd.x 0.008 = ~ 95,000 gpd.

A considerable amount of lime is required to raise the pH of the metal bearing wastes to 9.0, because of their alkalinity. Lime treatment results in a reduction in alkalinity and improved removals of copper and zinc. Sludge volume is markedly increased as a result of precipitation of calcium carbonate (softening reaction) and copper and zinc hydroxides. Lime treatment of the wastes, in addition to the costs, would about double the amount of sludge to be disposed of.

Treatment of the metal bearing wastes with lime was not considered necessary for reasons that will be presented in the section of this report dealing with "Selection of Treatment Method."

SELECTION OF TREATMENT METHOD

At an early stage in the investigation at Monsanto Village, the question of segregating the wastes into two streams, one containing the phenol bearing wastes and the other metal bearing wastes, was raised. As the field and laboratory studies progressed, the arguments for segregation and separate treatment were strengthened considerably. Preliminary estimates indicated that the necessary changes required in the sewer system to accomplish separation of the phenol and metal bearing wastes would cost about $300,000. Similar estimates indicated a saving of about $700,000 in the activated sludge facilities needed to treat only the phenol bearing wastes, rather than the total waste flow. Thus, a net saving of about $400,000 plus other benefits, such as reduced operating costs, were considered possible.

A summary of construction and capital costs for separation of the Monsanto Village wastes and building two treatment plants, one for phenol bearing wastes and one for metal bearing wastes, as opposed to treatment of the combined wastes in a single plant, is shown in Table 10. The cost estimates are based upon sludge disposal by lagooning operations only because other methods of disposal were found to be more costly, as will be discussed in a subsequent section of this report. From the information in Table 10, it was estimated that segregation of wastes and construction of two treatment plants

Table 10. Comparison of Capital Costs

	Combined Wastes Plan I	Segregated Wastes Plan II	Plan III
Construction Costs	$4,740,000	$4,400,000	$4,194,000
Total Capital Costs	6,658,000	6,238,000	5,978,000

Note: See Appendix E for detailed estimates.

would result in savings in construction costs of from $340,000 to $546,000 and savings in capital costs of from $420,000 to $680,000. Since other considerations enter into the final selection of a treatment system, a discussion of each of the three plans is presented.

Plan I - The details of Plan I involving treatment of the combined Monsanto Village waste flow in one treatment plant are shown in Fig. 4. By this scheme, all wastes would flow in common to the existing pumping station. Provisions would be made to neutralize the mineral acidity at this point. The wastes would then be pumped to clarifiers designed to remove floating and settleable matter. The clarified waste would then pass on to a neutralizing tank for final adjustment of pH to about 8.0. In the event the acidity of the wastes exceeds the capacity of the lime feeding facilities, some of the incoming flow would be diverted to the emergency storage lagoon and returned to the system at a more favorable time.

The neutralized wastes would flow to activated sludge aeration tanks of the completely mixed type with a detention period of 5-6 hours. Following final clarification in settling tanks, designed to remove activated sludge for return to the aeration tanks, the clarified effluent would flow to the river.

It is estimated that waste sludge volumes would approximate 165,000 gpd., with 15,000 gpd. from the primary clarifiers and 115,000 gpd. as waste sludge from the activated sludge units.

A total of about 190 acre feet of liquid sludge would be produced per year. It is estimated that two 60-acre lagoons, or a total of 120 acres of lagoon area, would be required for sludge disposal. This is based on employing lagoons 3 ft. deep and operated on an alternate annual basis, with intervening years reserved for drying of the sludge and removal of the cake to a final disposal site. Since there are only 122 acres of land available for the development of waste treatment facilities and sludge disposal facilities in the neighborhood of the Monsanto Village pumping station, it is obvious that 120 acres cannot be allocated to sludge lagoons. Plan I, therefore, would require more land area or utilization of more expensive methods of sludge disposal.

However, Plan I would produce a final effluent which would meet the requirements of the Mississippi River in all respects. The anticipated phenol content of the final effluent would be 1.4 mg./L, which for a flow of 38 mgd. corresponds to 445 lb. of phenol per day. At the considered minimum flow of 45,000 cfs. in the Mississippi River, this would increase the concentration in the river by 1.8 ppb. A stated objective of Regulatory Authorities concerned with pollution of the Mississippi River is to limit the contribution by Monsanto Village in a manner so that the phenol level in the Mississippi River will not be increased by more than 2 ppb. It may be concluded, therefore, that Plan I would meet the phenol requirement, but with a very small factor of safety.

SLUDGE DISPOSAL METHODS CONSIDERED

General.

Cost estimates for four alternate plans of sludge disposal were made to determine the most economical method. A summary of the results of the studies is given in Tables 12 and 13. Detailed estimates are listed in Appendix E, Tables E-3 to E-10, inclusive.

Cost estimates are included for waste treatment Plans II and III only. Sludge disposal costs for the other methods of waste treatment can be evaluated from these two studies, as the proportionate costs of the various methods would be similar for all plans. The cost of 95 acres of land is included in each method of sludge disposal since, under any of the plans, it would be advisable to purchase the entire 122 acre tract. This should be done because of uncertainties of the availability of other sludge disposal areas in the future, and to ensure availability of land in the event it became necessary to revert to another method of disposal requiring more area.

In Plans II-A to II-D, inclusive, both primary and waste activated sludge from the treatment processes would be handled in each case. In Plans III-A to III-D, inclusive, only primary sludge would be handled, the excess activated sludge being wasted to the river. Logically, as is shown in Tables 12 and 13, the smaller the amount of sludge to be

Table 12. Sludge Disposal Alternates for Plan II

Summary of Estimated Costs

Plan	Description	Estimated Capital Costs	Estimated Annual Costs
II-A	All sludge lagooned, disposal by landfill.	$1,078,000	$ 96,500
II-B	All sludge dewatered on vacuum filters, disposal by landfill	2,198,000	222,000
II-C	All sludge dewatered on vacuum filters and incinerated to ash, disposal by landfill	2,826,000	370,800
II-D	All sludge pumped to central sludge processing plant at East St. Louis, Illinois	858,000	170,300

Note: Estimated Annual Costs are based on present day costs - no escalation factor has been applied. The cost of 95 acres of land is included for all plans. Administrative costs are not included.

Table 13. Sludge Disposal Alternates for Plan III

Summary of Estimated Costs

Plan	Description	Estimated Capital Costs	Estimated Annual Costs
III-A	Primary sludge lagooned, disposal by landfill-Activated sludge wasted to river.	$ 823,000	$ 72,000
III-B	Primary sludge dewatered on vacuum filters, disposal by landfill-Activated sludge wasted to river	1,392,000	152,500
III-C	Primary sludge dewatered on vacuum filters and incinerated, disposal of ash by landfill-Activated sludge wasted to river.	1,666,000	269,500
III-D	Primary sludge pumped to central sludge processing plant at East St. Louis-Activated sludge wasted to river.	725,000	110,700

Note: Estimated Annual Costs are based on present day costs - no escalation factor has been applied. The cost of 95 acres of land is included for all plans. Administrative costs are not included.

handled, the less expensive would be the cost of disposal. Therefore, further discussion of each method of disposal can be limited to comparisons under Plan III.

Sludge Lagoons.

The adequacy of the available land area and a description of the construction of the lagoons under Plan III-A (the recommended plan) is included elsewhere in this report.

From laboratory experiments and an analysis of evaporation and rainfall to be expected in the St. Louis area, the sludge on the beds should dry satisfactorily to a thickness of approximately 6 in. in one year. Since the lagoons would be alternated annually, sludge removal would commence after one year's operation. We anticipate that this can be done with a standard medium-duty front-end loader, which would remove the sludge from the lagoon to dump trucks for hauling to the landfill area. The sludge in the landfill area should be leveled and compacted as it is placed.

The anticipated quantity of dried sludge would amount to approximately 16,000 cu. yd. annually. Estimating that two trucks can haul 100 cu. yd. per day, 160 working days would be required.

In actual practice, only half this number of working days may be available due to weather and other conditions. Accordingly, adjustments in equipment and labor requirements would be necessary to meet the needs.

Sludge Dewatering.

Under Plan III-B, we estimate that a total of 58,000 gpd. of sludge at a solids concentration of from 4 to 5 percent would be produced. Vacuum filtration studies indicated that filter yields for the various sludges would approximate 1.0 lb. per square foot per hour. On this basis, 58,000 gpd. of sludge would require a minimum of 1,000 sq. ft. of filter area. In our cost estimate, we have allowed for three 500-sq. ft. vacuum filtration units, one of which would be a spare. The spare filter is considered essential because it is anticipated that sludge quantities will require operation of two filters on a 24-hour a day basis. For this reason a standby filter should be available for cleaning periods, repair time, and other occasions when a filter is out of service.

No provisions for chemical conditioning would be required because of the nature of the sludge. An emergency sludge lagoon would be provided for holding seven days' sludge production in the event of temporary mechanical difficulties.

After dewatering, sludge would be loaded onto trucks for hauling to a landfill area. We estimate two trucks would be required for this daily one shift operation. Hopper storage capacity for at least one days' sludge cake production would be required, assuming 6-day, 8-hour hauling and 7-day, 24-hour dewatering operations.

Sludge Dewatering with Incineration.

The number of vacuum filters required in Plan III-C would be reduced to two since filter yields would approximately double when conditioned with ash from the incinerator.

An emergency lagoon of 7-day storage capacity would be provided for wet sludge in the event of mechanical difficulties.

Dewatered sludge would be transported mechanically to the Incinerator Building where two incinerators would be provided. An investigation of the Btu. (British thermal unit) values of the sludges was made and indicated that the sludge from the primary clarifiers would require auxiliary fuel to complete incineration. Under Plan III-C, the primary sludges would be combined before incinerating because of the small quantity from the phenol-acid bearing wastes. (Under Plan II-C, the sludges would be incinerated separately.) We have assumed 7-day, 24-hour operation in both plans. Since the volume of incinerated sludge would be approximately one-half that of the wet sludge cake, one truck would be required for hauling ash to disposal.

Because the sludge from treatment of the metal bearing wastes contains considerable amounts of copper and zinc, consideration was given to the possible salvage value of the incinerator ash. Although the ash was found to contain about 5 percent of copper and 8 percent of zinc, replies to inquiries directed to the Lewin Mathes Company and the Darling Fertilizer Company indicated that the ash would have little, if any, salvage value in the St. Louis area. Thus, it was concluded that there would be no possibility of reducing the costs of incineration.

<u>Pumping to the Proposed East St. Louis Central Sludge Processing Plant.</u>

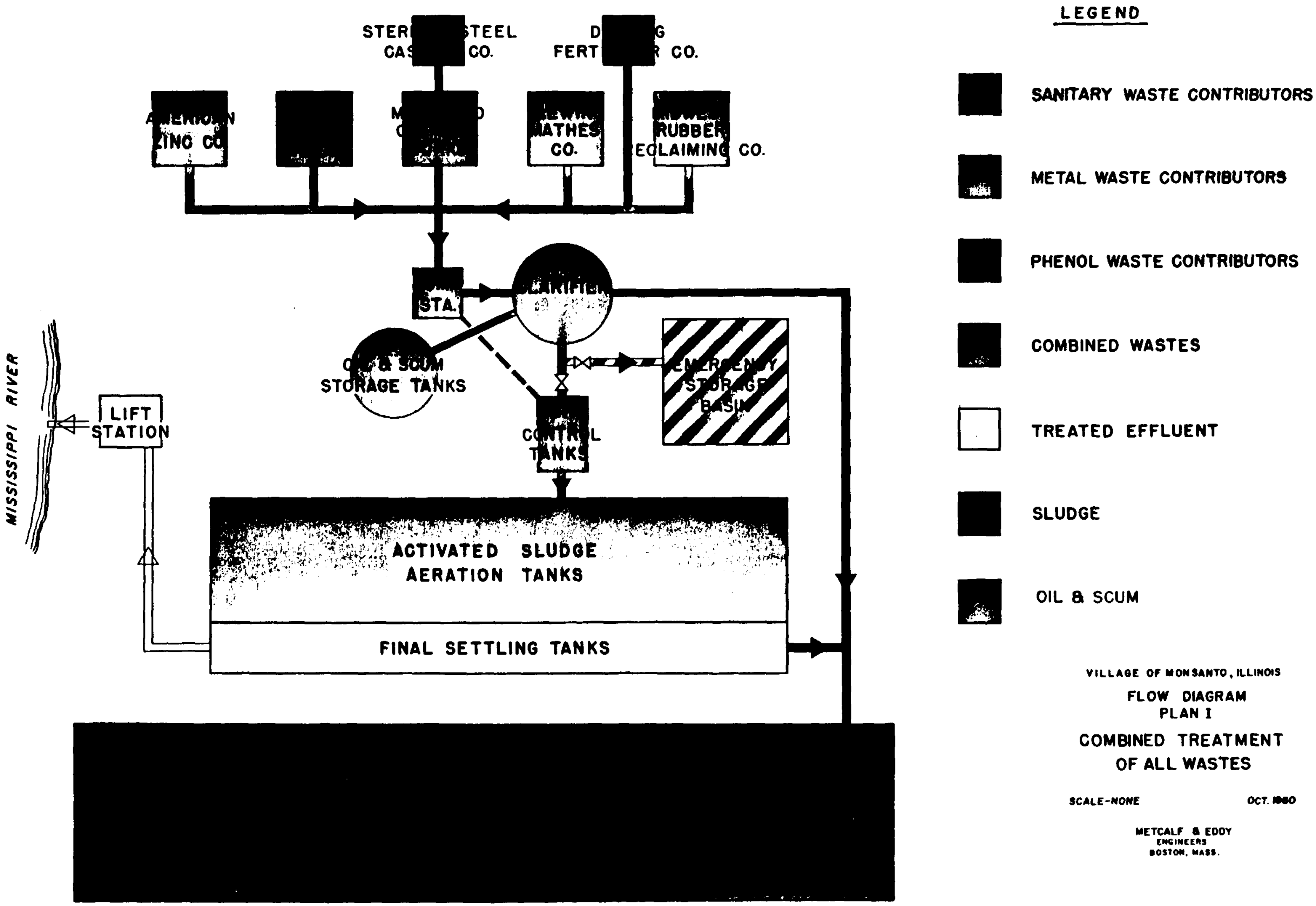
Under Plan III-D, all sludge from the Monsanto Village plant would be pumped to the proposed sludge processing plant of the East Side Levee and Sanitary District to be located near the East St. Louis outlet.

Sludge pumping facilities would be provided with heavy-duty positive displacement pumping equipment, since high pumping heads would be encountered. These facilities would operate a total of three to four hours each day. Separate sludge pumping stations would be provided for the two types of primary sludge.

Approximately one mile of forcemain would be required to the central processing plant. An allowance has been made for a portion of this line to be constructed in easements, but no deduction was made to account for use of the sludge line by the Village of Cahokia.

Here again, an emergency lagoon would be provided for storage of seven days' sludge production.

For this study, proportionate annual costs for the central sludge processing plant were estimated from data listed in Horner & Shifrin's 1959 report.



VILLAGE OF MONSANTO, ILLINOIS

FLOW DIAGRAM
PLAN I

COMBINED TREATMENT
OF ALL WASTES

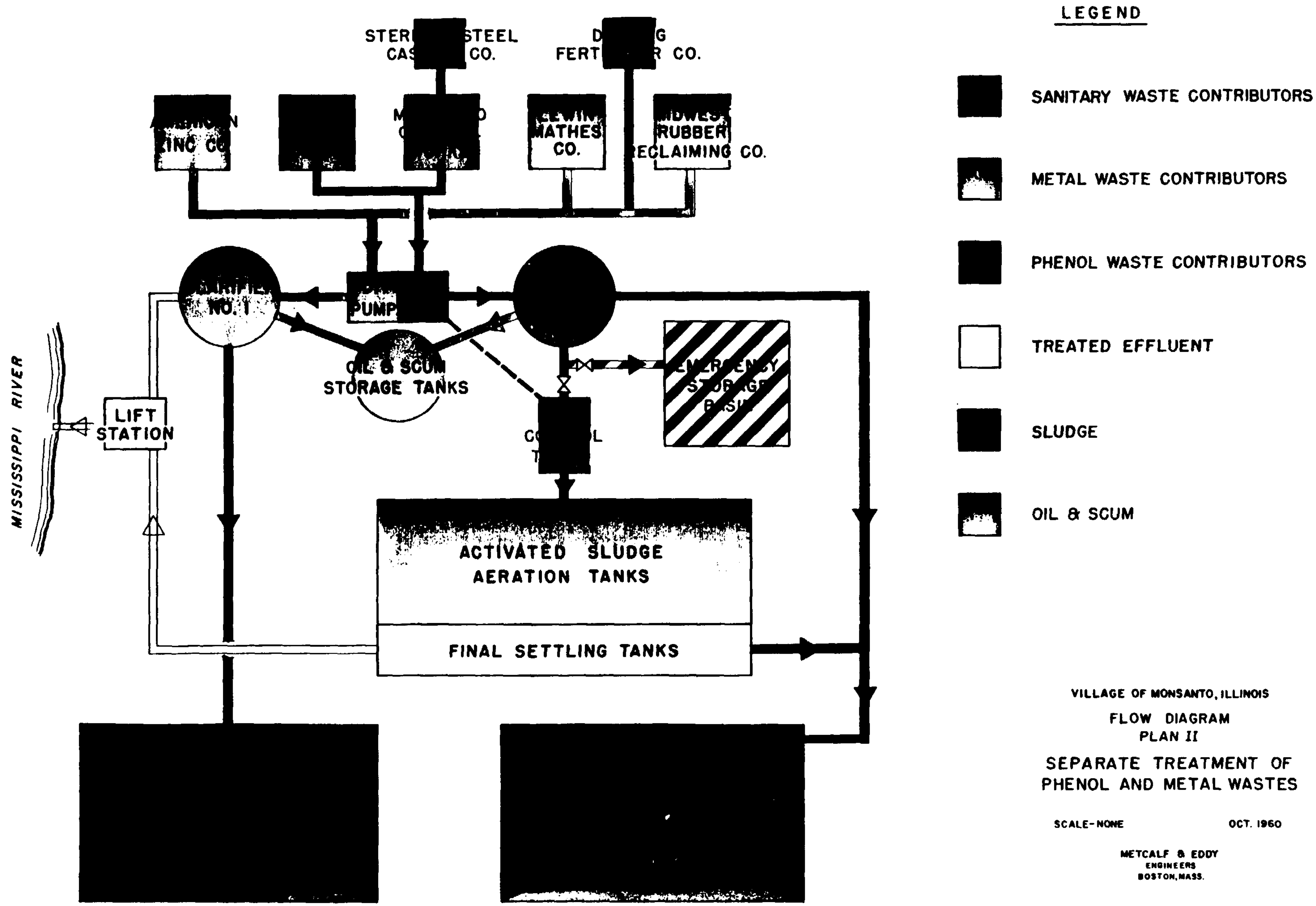
SCALE-NONE OCT. 1960

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

FIG. 4

Plan II - The details of Plan II involving segregation of the metal bearing wastes from the phenol bearing wastes and separate treatment of the two waste streams are shown in Fig. 5. In this scheme, the wastes from American Zinc, Darling Fertilizer, Lewin Mathes, and Midwest Rubber companies would be intercepted and transported separately to the present pumping station which would be divided in a manner to keep the wastes separate.

The metal bearing wastes would be pumped to clarifiers designed to remove floatable and settleable matter. The floatable matter consisting largely of oil and grease would be transferred to a storage tank, the sludge removed for land disposal, and the clarifier effluent containing some unprecipitated copper and zinc released for discharge to the Mississippi River. When this effluent is diluted with the effluent from the activated sludge units treating the phenol bearing wastes, it is predicted that the zinc and the copper content of the total effluent stream will approximate 9 and 1.1 mg./L, respectively. At the considered minimum flow of 45,000 cfs. in the Mississippi River, the zinc and copper content of the river water will be increased by 12 and 1.4 ppb., respectively, amounts which can be considered insignificant. Therefore, it was concluded that treatment of the metal bearing wastes with lime to accomplish greater removals of zinc and copper is not justified.



VILLAGE OF MONSANTO, ILLINOIS

FLOW DIAGRAM
PLAN II

SEPARATE TREATMENT OF
PHENOL AND METAL WASTES

SCALE-NONE OCT. 1960

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

FIG. 5

The phenol bearing wastes would be treated at the pumping station to neutralize mineral acidity in as far as is feasible, and then pumped to clarifiers for removal of floatable and settleable solids. The clarifier overflow would pass to neutralizing tanks where hydrated lime would be added to raise the pH to about 8.0 in preparation for activated sludge treatment. Facilities would be provided for bypassing part of the flow to the emergency storage lagoons in case the acidity of the wastes should exceed the capacity of the neutralizing facilities.

The neutralized wastes would flow to activated sludge aeration tanks of the completely mixed type with a detention period of 5 to 6 hours. After final sedimentation to remove activated sludge, the clarified effluent would flow to the river.

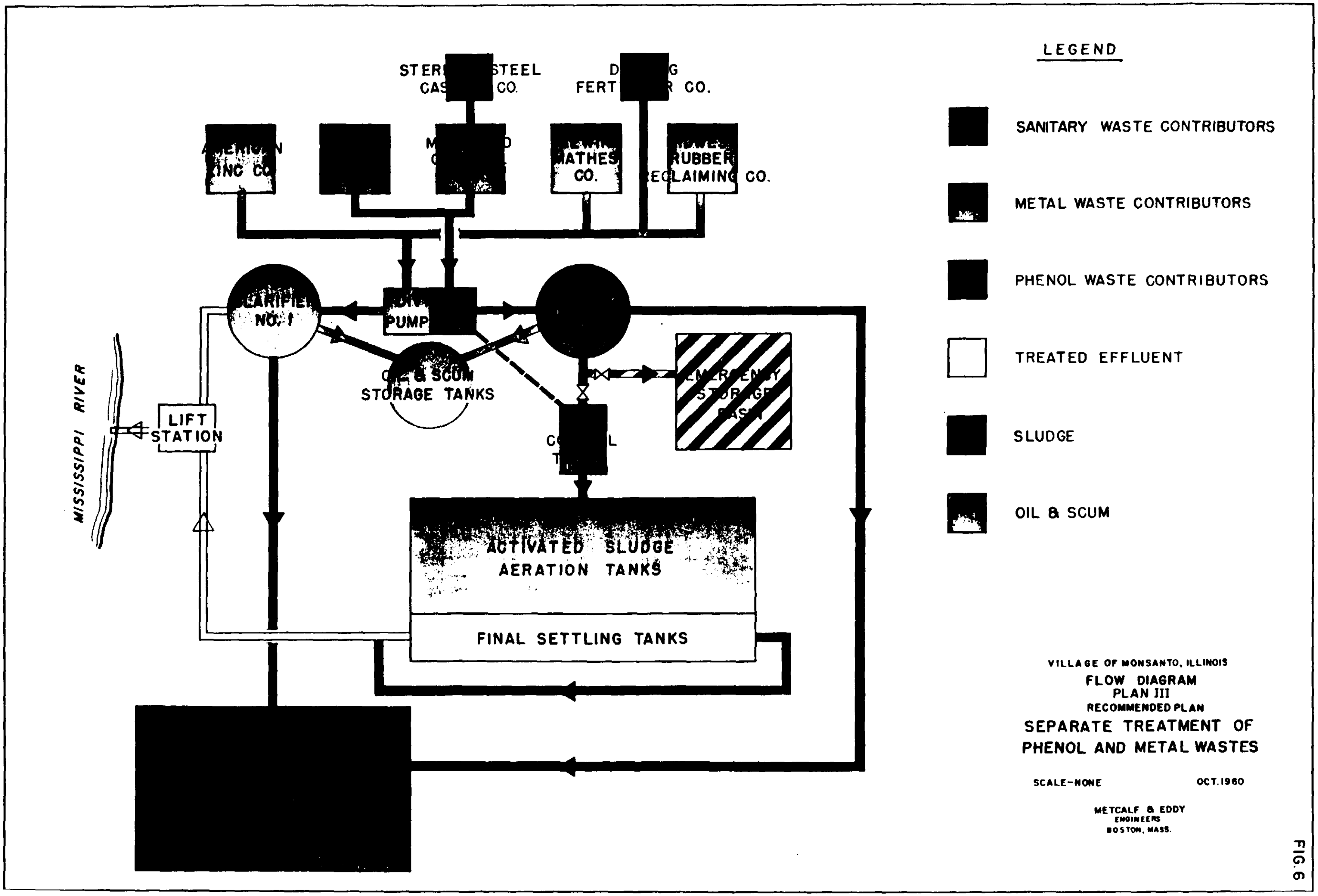
It is estimated that the waste sludge volumes under Plan II would approximate 108,000 gpd., 50,000 gallons would originate from the clarifiers treating the metal bearing wastes, 8,000 gallons from the primary clarifiers handling phenol bearing wastes, and 50,000 gallons of waste activated sludge. Approximately 120 acre feet of liquid sludge would be produced per year. It was estimated that two 40-acre lagoons, or a total of 80 acres of lagoon area, would be required for sludge disposal, employing lagoons 3 ft. deep and operated on an alternate annual basis as described under Plan I.

There are only 122 acres of land available for development of waste treatment and disposal facilities in the immediate vicinity of the Monsanto Village pumping station. It is considered prudent to reserve about 25 acres of this area for structures needed for present requirements and room for expansion in the future. With 80 acres allocated to sludge lagoons, only 15 to 17 acres remain for final disposal of sludge cake removed from the lagoon area. In our opinion this area would meet the requirements of the Village for about 10 years, then additional land would be required.

Plan III - In view of land area limitations and the cost of other methods of disposal employing mechanical dewatering of sludge, as will be discussed subsequently, consideration was given to disposing of the excess activated sludge in a totally different manner. This involved its controlled release in the final effluent to the Mississippi River. The details of Plan III are shown in Fig. 6 and differ only from those of Plan II, Fig. 5, with respect to method of disposal of the excess activated sludge.

A considerable number of factors were evaluated in making the decision to recommend Plan III. The major ones were as follows:

1. The phenol bearing wastes, after clarification to remove floatable and settleable matter, and after neutralization, would be acceptable for disposal to the Mississippi River, were it not for their phenol content.



LEGEND
SANITARY WASTE CONTRIBUTORS
METAL WASTE CONTRIBUTORS
PHENOL WASTE CONTRIBUTORS
TREATED EFFLUENT
SLUDGE
OIL & SCUM
MISSISSIPPI RIVER
LIFT STATION
PUMP
NO. I
STORAGE TANKS
ACTIVATED SLUDGE AERATION TANKS
FINAL SETTLING TANKS
CO.
RUBBER
VILLAGE OF MONSANTO, ILLINOIS
FLOW DIAGRAM
PLAN III
RECOMMENDED PLAN
SEPARATE TREATMENT OF
PHENOL AND METAL WASTES
SCALE-NONE
OCT. 1960
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

FIG. 6

2. Activated sludge treatment is employed solely for destruction of phenolic compounds.

3. Biological changes occurring in natural waters are comparable to those which take place in activated sludge plants. This means that an amount of biological solids, comparable to those produced in an activated sludge plant, will develop in a river which receives wastes of a quality passing to the aeration tanks of an activated sludge plant. If there is no objection to the formation of these biological solids in the river, then there should be little reason to object to the discharge of such solids after they have served a useful purpose, such as destruction of phenol.

4. Activated sludge solids are of the same type and character as the natural biological growths occurring in streams. They are reasonably well oxidized and are much less putrescible than the solids escaping from primary treatment plants handling domestic wastes.

5. Calculations indicate that the waste activated sludge resulting from treating the phenol bearing wastes will carry about 16,800 lb. of solids per day. Discharge of this amount of solids to the combined effluent from the Monsanto Village plants, 38 mgd., will increase the suspended solids by 53 mg./L.

6. Finally, it is estimated that the suspended solids in the final effluent will be composed as follows:

	38 mgd. flow
Normal activated sludge effluent 26 mgd. @ 30 mg./L	22
Metal bearing wastes effluent 12 mgd. @ 50 mg./L	16
Waste activated sludge 50,000 gpd. @ 4% solids	53
	91 mg./L

From this, it is concluded that the final effluent from Monsanto Village with waste activated sludge will contain suspended solids in the order of the amount expected in the effluent from primary treatment plants in the St.Louis area, and the solids, because they are partially stabilized, will be much less objectionable in the Mississippi River than corresponding solids from primary treatment plants.

Under Plan III, the amount of sludge to be disposed of by lagooning operations will be reduced to about 58,000 gpd. This corresponds to 65 acre feet of liquid sludge per year. It is estimated that two 20-acre sludge lagoons will suffice. Allowing 25 acres for waste treatment facilities and 40 acres for sludge lagoons, 57 acres of the total of 122 remain for sludge disposal and other requirements. It is estimated that the area will serve adequately for at least 40 years.

Plan III will produce a final effluent that will meet the requirements for the Mississippi River in all respects. The anticipated phenol content of the final effluent is 1.3 mg./L, which for a flow of 26 mgd. corresponds to 280 lb. per day. At the considered minimum flow of 45,000 cfs. in the Mississippi River, this would increase the concentration by 1.2 ppb. This provides a much greater safety factor in terms of the limit of 2 ppb. desired by the Regulatory Authorities than could be expected under Plan I.

Recommended Treatment Plan.

In view of all considerations expressed above, the following plan is recommended:

1. Provide for segregation of wastes on the basis of metal and phenol content as shown in Fig. 7.
2. Provide treatment facilities according to Plan III, Fig. 6.

Justification for the recommendations is summarized in Table 11. From this it will be noted that Plan III, is preferable in all respects, except for suspended solids. This matter has been discussed to a considerable extent above, with the conclusion that it is not of sufficient importance to mitigate against adoption of Plan III.

METHOD OF HANDLING FLOATABLE MATTER

During the course of the survey at Monsanto Village, frequent observations at the Village pumping station illustrated the fact that the wastes contain a great deal of floating matter, largely heavy machine oils and grease. At the conclusion of the sampling program, the consensus was that a major part of the oil and grease originated from the Midwest Rubber Company with appreciable amounts from Mobil Oil, Lewin Mathes, and Monsanto Chemical companies. No attempt was made to evaluate the contributions from the various industries as it was deemed necessary to provide facilities for removal of floatable matter and hopes were expressed that the floatable matter might have some salvage value, which would eliminate a final disposal problem.

At one time samples of floating matter were collected at the Village pumping station and submitted to a St. Louis area firm for evaluation. The oral report received was favorable. Since Metcalf & Eddy was not in a position to guarantee the sustained quality, nor the quantity, of floatable matter that will be available, we did not press for a firm commitment.

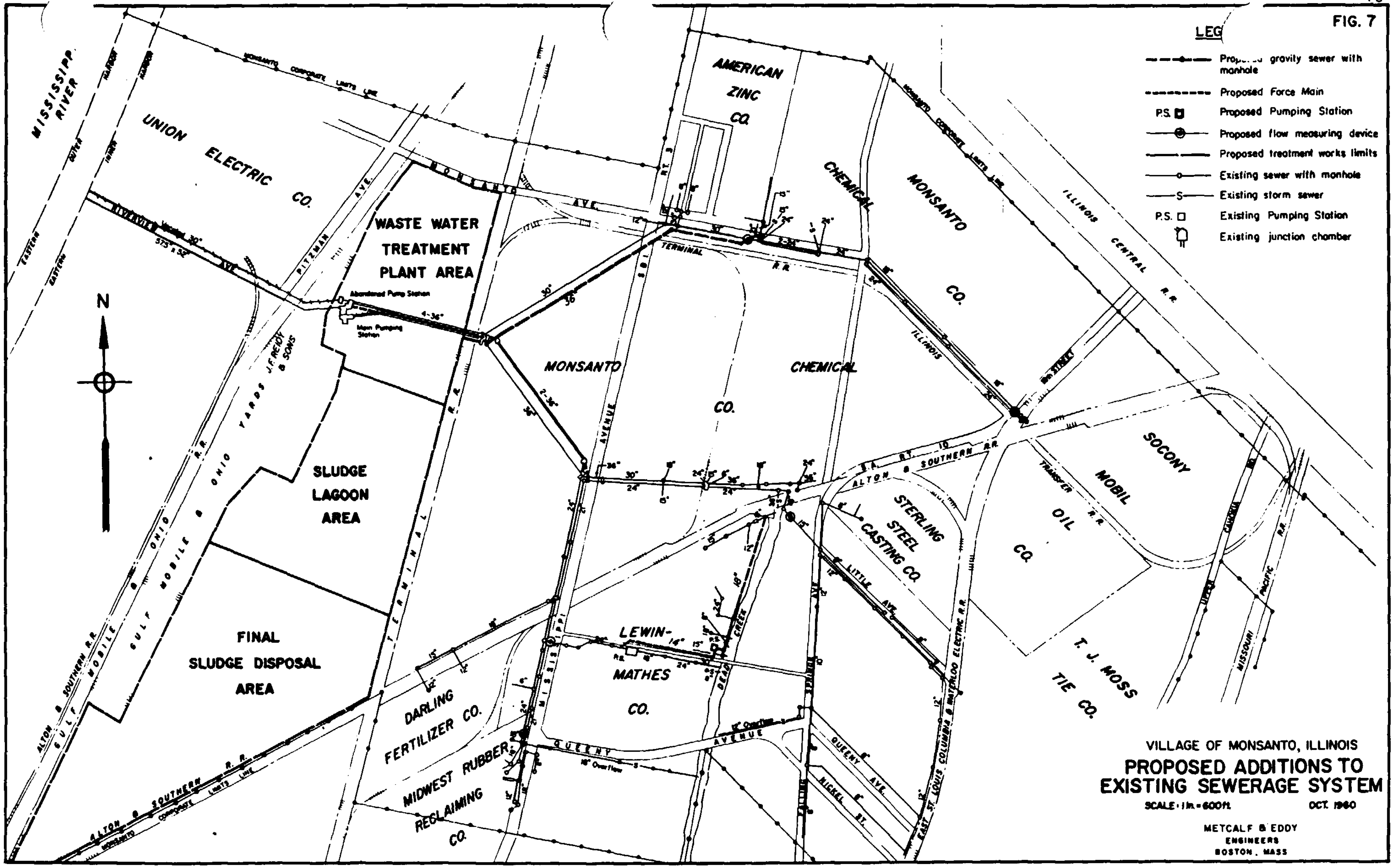
It is our opinion that the floatable matter collected, when properly screened to remove trash materials, will have a salvage value. For this reason, all plans for treatment of Monsanto Village wastes provide simple storage facilities for floatable matter, only.

In case the floatable matter should prove to have no salvage value, disposal by land fill is recommended. This is another reason for recommending Plan III, so that the necessary land will be available.

Table 11. Justification of Recommended Plan of Waste Treatment

	Plan I Combined Wastes	Plan III Separate Wastes
Capital Costs	$6,658,000	$5,978,000
Annual Costs*	1,095,000	988,000
Lime Requirements	Same	Same
Land Area	Inadequate	Adequate
Removal of Floatable Matter	Excellent	Excellent
Suspended Solids in Effluent	30 mg./L	91 mg./L
Phenol in Effluent	445 lb.	280 lb.
Increase in phenol content of Mississippi River at min. flow	1.8 ppb.	1.2 ppb.

NOTE: See Tables E-1 and E-2 Appendix E for detailed estimates.



38126-Z-14203

RECOMMENDED PLAN OF WASTES TREATMENT

Alterations to the Existing Sewerage System.

As previously concluded, separation of the phenol-acid and metal bearing wastes is economically advantageous. To accomplish this, several additions and modifications would be required. These are schematically shown on Fig. 7. A new 36-in. sewer to carry the present estimated average flow of 5.4 mgd. from the American Zinc Co. would be constructed from their plant to the Main Junction Chamber. To intercept flows from the Lewin Mathes Co. property, presently emptying into Dead Creek, an 18-in. sewer would be constructed along the west bank of the creek to intercept the wastes flow of approximately 1.9 mgd. A new pumping station and force main would be required to lift these wastes into the Mississippi Avenue sewer.

Certain modifications, consisting primarily of new dividing walls, would be required at two junction boxes to maintain the division of flow.

Gaging stations would be provided to measure and sample each industry's flow wherever practical. It is anticipated that a weir box device and sampling equipment will be suitable for the Lewin Mathes Co. flow. Parshall flumes and continuous sampling equipment would be provided for Midwest Rubber Reclaiming Co., American Zinc Co., and Socony Mobil Oil Co. Flows from Darling Fertilizer can be estimated or obtained by water meter readings. Another Parshall flume gaging station for Sterling Steel Casting Co. and the domestic flow east of Falling Springs Avenue would be provided, primarily to determine the Monsanto Chemical Co. flow and wastes constituents more accurately by comparison with the total phenol-acid wastes measured and sampled at the treatment plant.

The north half of the Main Pumping Station would be converted to handle the phenol-acid bearing wastes. One of the two existing 36-in. influent sewers to the south half of the Main Pumping Station would be diverted to the north half and a new screen chamber added there. This would more evenly proportion the influent sewer flows to the converted Main Pumping Station to provide capacity for approximately twice the average dry weather flows of the metal and phenol-acid bearing wastes.

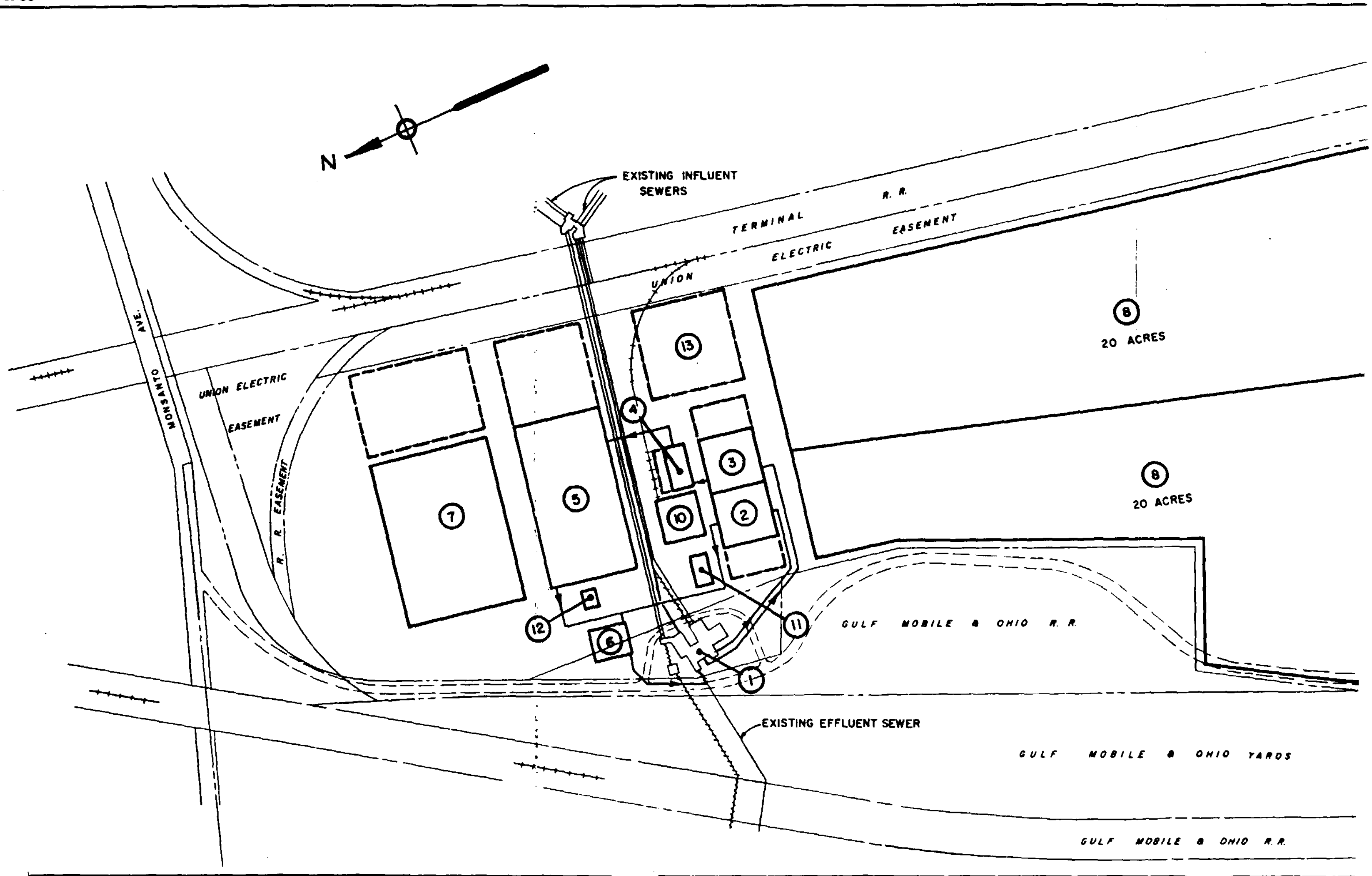
Within the existing Main Pumping Station, the present pumping units would be removed and replaced by new units. On the side devoted to handling the phenol-acid bearing wastes, three 9,000 gpm. variable speed pumps would be installed. For the metal bearing wastes, three 4,200 gpm. variable speed pumps would be installed. To obtain minimum installation costs, the new pumps should be the same as the existing pumps except for impeller diameter and operating speed. Changes to the electrical system would not be extensive. Other modifications would include new dividing walls as required, overflow connections from the screen chambers to the new flood pumping station and discharge connections from the surge towers to the treatment works.

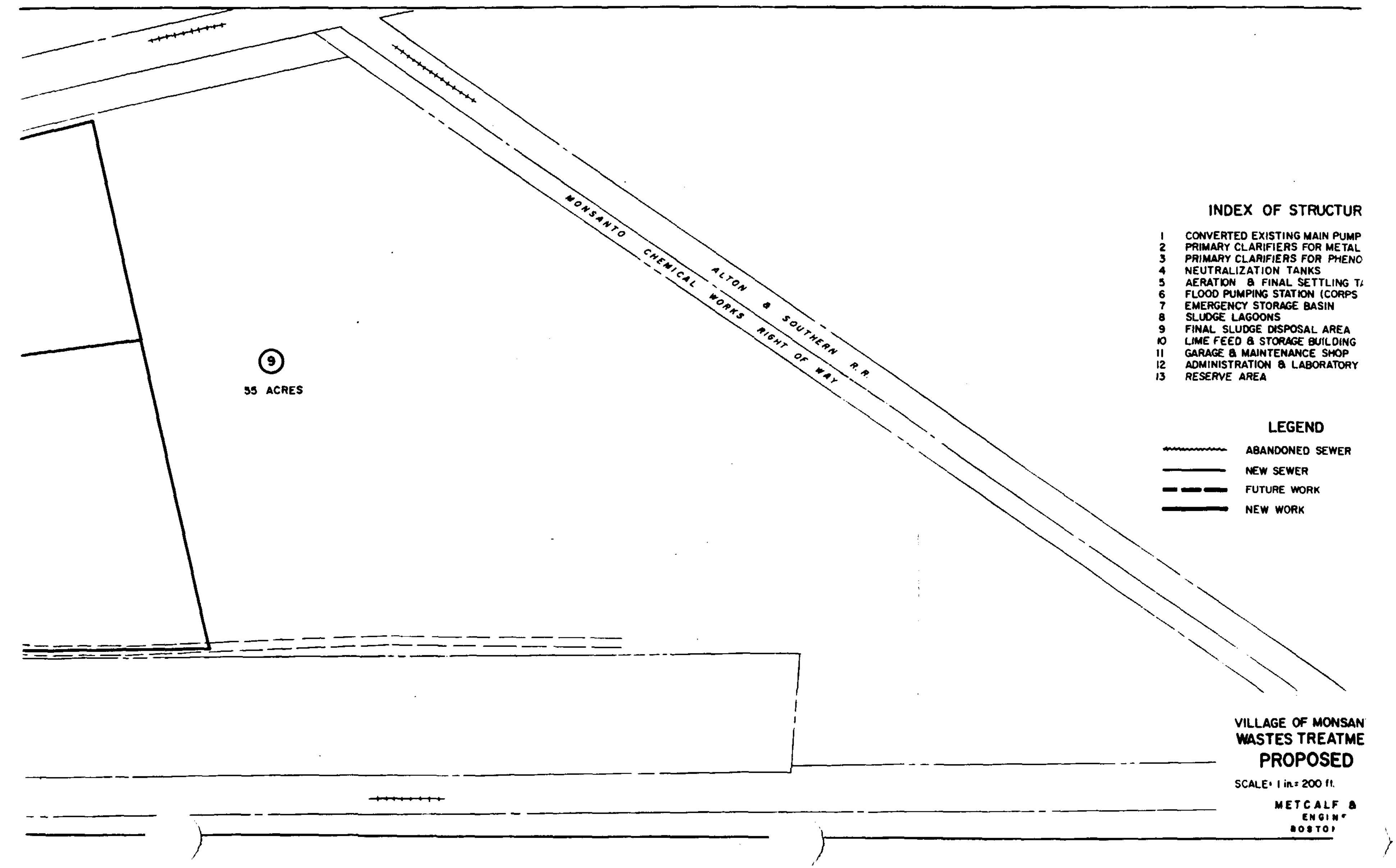
Proposed Waste Water Treatment Plant.

A plan of the proposed wastes treatment plant is shown on Fig. 8.

Primary clarifiers for the metal bearing wastes and phenol-acid bearing wastes would be conventional settling units. Provisions would be made for removing floating scum and oil. This material would be drained to an oil and scum storage tank for periodic disposal. Two sludge pumping stations would be provided, one for each battery of clarifiers, to pump sludge to the drying lagoons. Clarified waters from the metal waste battery would go to the plant outfall. Effluent from the phenol-acid wastes battery would flow to neutralizing tanks for pH control with lime. These tanks would also be conventionally constructed and contain mechanical mixing equipment.

Following neutralization, the phenol-acid bearing wastes would flow through the aeration and final settling tanks. The method of operation for these units was studied in detail to minimize construction costs. It is considered essential to provide at least four aeration tanks with corresponding settling tanks in order that any one of the units may be taken out of service for repair and still allow ʇɜɪʃ-ʃ-ɪɜ3ɔ


N
EXISTING INFLUENT SEWERS
TERMINAL R. R.
UNION ELECTRIC EASEMENT
MONSANTO AVE.
UNION ELECTRIC EASEMENT
R. R. EASEMENT
13
4
3
2
10
7
5
12
6
11
1
8
20 ACRES
8
20 ACRES
GULF MOBILE & OHIO R. R.
EXISTING EFFLUENT SEWER
GULF MOBILE & OHIO YARDS
GULF MOBILE & OHIO R. R.



MONSANTO CHEMICAL WORKS RIGHT OF WAY
ALTON & SOUTHERN R.R.
9
55 ACRES
INDEX OF STRUCTUR
1 CONVERTED EXISTING MAIN PUMP
2 PRIMARY CLARIFIERS FOR METAL
3 PRIMARY CLARIFIERS FOR PHENO
4 NEUTRALIZATION TANKS
5 AERATION & FINAL SETTLING T
6 FLOOD PUMPING STATION (CORPS
7 EMERGENCY STORAGE BASIN
8 SLUDGE LAGOONS
9 FINAL SLUDGE DISPOSAL AREA
10 LIME FEED & STORAGE BUILDING
11 GARAGE & MAINTENANCE SHOP
12 ADMINISTRATION & LABORATORY
13 RESERVE AREA
LEGEND
ABANDONED SEWER
NEW SEWER
FUTURE WORK
NEW WORK
VILLAGE OF MONSAN
WASTES TREATME
PROPOSED
SCALE: 1 in.= 200 ft.
METCALF &
ENGIN
BOSTO

treatment of the entire waste flow in the remaining three units. In view of the nature of the wastes to be treated, particularly the variation in phenol content, it is deemed most practical to provide aeration tanks of the completely mixed type. To this end, the influent to each unit would be evenly distributed along the full length of the tanks by means of weirs. Flow from the aeration tanks to the final settling units would be hydraulically controlled to allow the use of conventional sludge collecting equipment in rectangular final settling tanks. To further reduce costs, the final settling tanks would be designed on the basis of overflow rates of about 2,000 gpd./sq. ft. of surface area, rates competitive with those used in peripheral fed circular tanks. Activated sludge would be returned to the aeration tanks by positive action mechanical facilities. Waste activated sludge would be disposed of in the effluent by gravity flow. The effluent from the activated sludge final settling tank units would combine with the effluent from the primary clarifiers handling the metal wastes for discharge to the Mississippi River.

An Emergency Storage Basin would be provided in which highly acidic or otherwise objectionable flows can be stored. Prearrangement with the contributing industries should be made so that wastes which may unbalance the treatment process can be temporarily diverted. These wastes can then be returned for treatment at a slow rate over a period of days.

The sludge lagoons would be operated alternately each year, sludge being harvested from one 20-acre area each summer while the other is used to store wet sludge. Multiple inlets would be provided to evenly disperse the wet sludge in the lagoons. After drying, sludge would be removed from the lagoons by front end loaders, trucked to the final disposal area and spread as landfill.

The Lime Storage and Feed Building would contain lime storage bins, slurry mixing tanks and pumping and control equipment to feed lime slurry to the converted phenol-acid wastes wet well of the Main Pumping Station and to the neutralizing tanks. In this manner, mineral acidity would be neutralized at the pumping station before the waste is in contact with mechanical equipment. Thorough mixing would be ensured from the turbulent action of pumping. The remainder of the acidity would be neutralized in the neutralization tanks. Provisions would be made for storage of a 7-day supply of lime. An overhead crane system or belt conveyors would be provided to transport lime from the storage bins to the slurry tanks. Two batteries of slurry tanks would be provided; one to contain an 8-hour supply for the shift in operation and the second to be used to prepare lime slurry for the following shift. Pumping and control equipment would be provided to feed lime slurry as required.

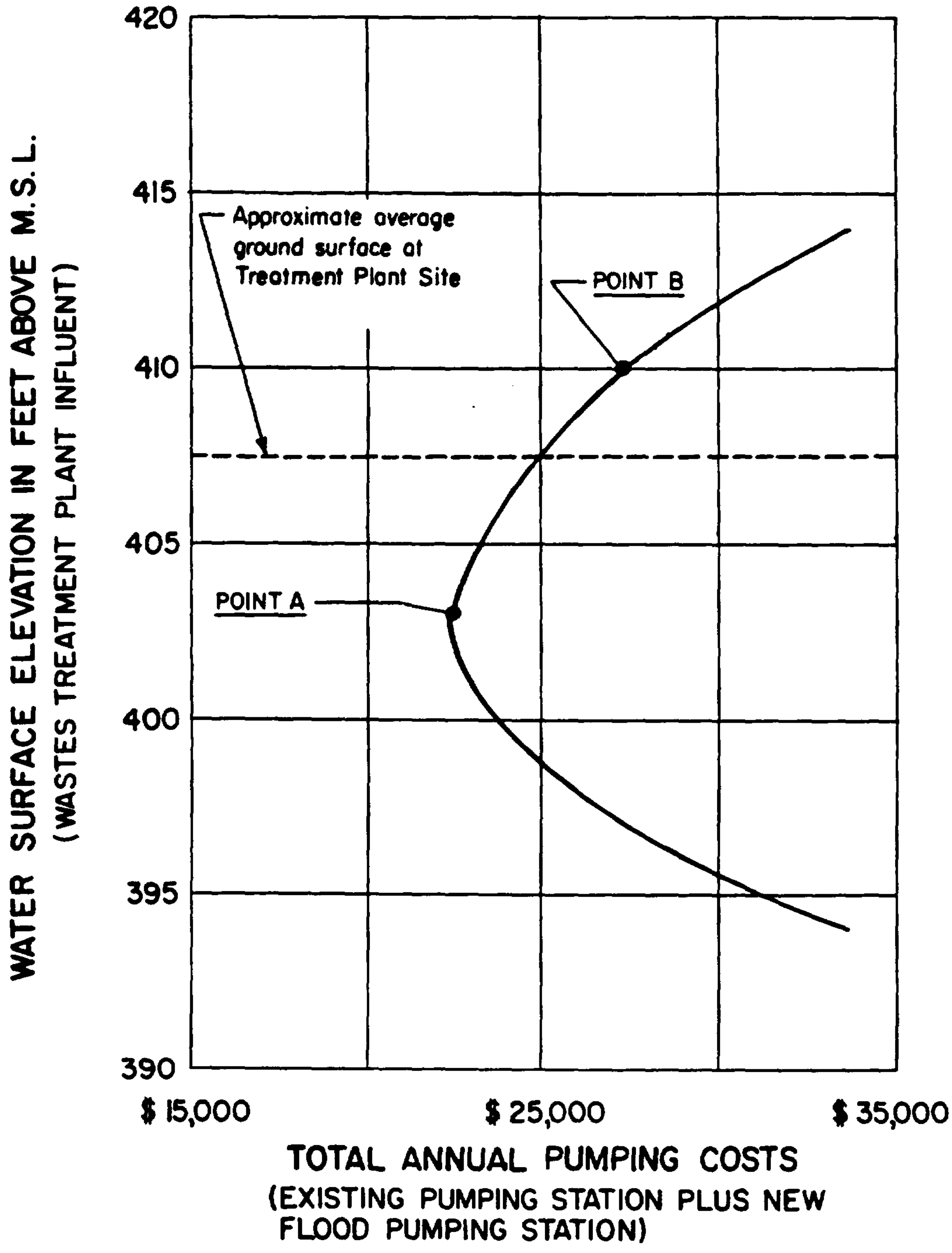
A Maintenance and Garage Building would house necessary shop equipment for general maintenance work and provide garaging space for vehicles.

The Administration and Laboratory Building would contain office space for supervisory personnel and a complete laboratory for all analytical work needed for control of operations and to serve as a basis of service charges.

A study was made to determine the most economical elevation for the plant structures considering pumping and excavation costs. The results of this preliminary study are shown on Fig. 9. Although the minimum annual combined pumping costs for the existing pumping station and proposed new flood pumping station occurs with an influent elevation of approximately 403.0 ft. above m.s.l. (mean sea level), the first cost of constructing the plant at this level is too great, since deep excavations would be required. Our investigations show that an influent elevation of approximately 410.0 ft. above m.s.l. is the most economical, considering both first cost and annual pumping costs. At lower elevations, the additional excavation cost is greater than the "present worth" of the annual pumping savings. At higher elevations, the lesser excavation costs are offset by the increased annual pumping costs.

The basic design data for the recommended plant are listed in Appendix F, Table F-1.

FIG. 9



NOTE:

POINT A; Approximate most economical water surface influent elevation, considering pumping costs alone.

POINT B; Approximate most economical water surface influent elevation considering pumping costs and excavation costs.

VILLAGE OF MONSANTO, ILLINOIS
WASTES TREATMENT PLANT
HYDRAULIC ELEVATION AT
PLANT INFLUENT

SCALE: AS SHOWN   OCT. 1960

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

38122-Z-14199

FINANCING

Methods of Financing.

Two methods of financing municipal construction which are commonly employed are (1) by the sale of general obligation bonds and (2) by the sale of revenue bonds.

By law, the State of Illinois limits the amount of outstanding general obligation bonds to 2-1/2 percent of the assessed valuation of the municipality. The 1959 assessed valuation of the Village of Monsanto was $58,719,981 and the amount of outstanding general obligation bonds, as of January 1, 1960, amounted to $244,000. This would permit, under statutory limits, the issuance of approximately $2,692,000 additional general obligation bonds. The necessary money for the capital costs of the sewerage facilities can be obtained by the sale of general obligation and revenue bonds.

We understand that at the present time steps are being taken by the Village authorities to obtain authorization for the sale of $2,500,000 worth of general obligation bonds. Accordingly, we have based our studies of the financial aspects of the sewerage construction program on the sale of $2,500,000 worth of general obligation bonds. The remaining costs amounting to approximately $3,478,000 would be defrayed by the sale of revenue bonds.

It is quite possible that the amounts of general obligation bonds and revenue bonds actually sold will differ from the amounts which we have assumed. In this case, the relative amounts to be paid from general taxation and from sewage service charges would, of course, change.

General obligation bonds would be repaid from general taxation on real estate in the Village of Monsanto. Revenue bonds would be repaid by levying sewage service charges against those using the sewerage facilities.

Federal Aid.

At the present time under Public Law 660 of the 84th Congress a Federal grant is available to a municipality for the construction of necessary treatment works to prevent the discharge of untreated and inadequately treated sewage or other wastes into any waters and for the purpose of reports, plans, and specifications in connection therewith. Under present regulations, 30 percent of the cost or $250,000 whichever is the lesser, may be available for any single project.

From time to time, bills have been introduced in Congress to raise the amount of funds available for this purpose. On the other hand, there has been at least one bill introduced to remove the control of the grant program from the Federal Government and turn it over to the individual states, with provision for supplying the necessary funds. Therefore, the amount of money which may become available to the Village from either the Federal Government or the State is subject to change from present conditions.

In view of the uncertainty as to the amount of Federal or State funds which may be available, we have not included the possibility of such aid in our estimates of cost.

Also at the present time, under Public Law 560 of the 83rd Congress, provision is made for a municipality to obtain, through the Housing and Home Finance Agency, an interest free loan for financing the cost of engineering and architectural surveys, designs, plans, working drawings, and specifications for the construction of public works. This loan must be repaid when the construction work is commenced.

Annual Costs.

The estimated total annual costs are made up of annual fixed costs and annual operating costs.

The annual fixed costs are for paying off the bonded indebtedness and consist of payments on the principal, interest, and, in the case of revenue bonds, an additional amount (coverage) necessary to secure an attractive interest rate.

For purposes of computing the annual fixed costs, we have assumed the general obligation bonds to have an interest rate of 3-1/2 percent and to mature in 20 years. The revenue bonds have been assumed to have an interest rate of 5 percent and to mature in 30 years. Retirement of the bonds would be scheduled so that payments of principal and interest would result in approximately equal annual payments.

In order to obtain a more favorable rate of interest for the revenue bonds, a minimum coverage of 25 percent in excess of the annual payments for the bonds was assumed. This would be used to establish a reserve fund equal to one year's fixed costs plus operation costs. After the establishment of the reserve fund, the excess would be carried in a bond retirement fund and used to retire the bonds at an earlier date.

Annual operating costs are made up of salaries and administration, maintenance and replacement of equipment, chemicals for the neutralization of the acid wastes and the cost of the necessary electric power to operate the plant. In computing the annual operating costs, a yearly increase has been assumed to reflect the present rising trend in salaries and materials as explained in Appendix E.

The assumed operating personnel requirements are listed in Appendix E, Table E-12.

The estimated annual costs and the required revenues to defray these costs are listed in Tables 14 and 15.

In the preparation of Tables 14 and 15, the annual fixed costs or debt service are based on the retirement of revenue bonds only. As explained previously, we have assumed that $2,500,000 in general obligation bonds would be sold and that sufficient revenue bonds would be issued to finance the remaining costs. The debt service for the general obligation

Table 14. Annual Costs and Proposed Revenues from Sewage Service Charges (Recommended Method)

Year	Revenue bonds issued, dollars	Total revenue bonds issued dollars	Debt service-revenue bonds, dollars	Operation and administration costs, dollars	Total annual costs, dollars	Proposed revenue, dollars	Coverage, percent	Annual surplus, dollars	Bond reserve fund balance, dollars	Surplus[a] fund balance, dollars	Bond retirement fund balance, dollars	Surplus applied to capital costs, dollars
1962	$ --	$ --	$ --	$ 18,500	$ 18,500	$ 867,000	--	$ 848,500	$ --	$ 848,500	$ --	$ --
1963	--	--	--	25,600	25,600	867,000	--	841,400	--	889,900	--	800,000
1964	1,789,000	1,789,000	116,400	26,700	143,100	867,000	621.9	723,900	116,400	608,400	--	889,000
1965	--	1,789,000	116,400	639,800	756,200	867,000	95.1	110,800	116,400	719,200	--	--
1966	--	1,789,000	116,400	657,100	773,500	867,000	80.4	93,500	116,400	773,700	39,000	--
1967	--	1,789,000	116,400	677,600	794,000	867,000	62.6	73,000	116,400	794,700	91,000	--
1968	--	1,789,000	116,400	698,100	814,500	867,000	45.0	52,500	116,400	815,200	123,000	---
1969	--	1,789,000	116,400	719,200	835,600	867,000	27.0	31,400	116,400	835,600	134,000	--

[a] Interest earned by surplus not included

Notes:
Debt service on an assumed amount of $2,500,000 of general obligation bonds is not included in the above costs. These bonds would be retired by payments from general property taxes.

Table 15. Annual Costs and Proposed Revenues from Sewage Service Charges
(Alternate Method)

Year	Revenue bonds issued, dollars	Total revenue bonds issued dollars	Debt service-revenue bonds, dollars	Operation and administration costs, dollars	Total annual costs, dollars	Proposed revenue, dollars	Coverage, percent	Annual surplus, dollars	Bond reserve fund balance, dollars	Surplus[a] fund balance, dollars
1962	$ --	$ --	$ --	$ 18,500	$ 18,500	$ 18,500[b]	$ --	$ --	$ --	$ --
1963	800,000	800,000	40,000[c]	25,600	65,600	65,600[b]	--	--	--	--
1964	2,678,000	3,478,000	173,900[c]	26,700	200,600	200,600[b]	--	--	--	--
1965	--	3,478,000	226,200	639,800	866,000	1,006,000	62.0	140,000	140,000	--
1966	--	3,478,000	226,200	657,100	883,300	1,006,000	54.3	122,700	226,200	36,500
1967	--	3,478,000	226,200	677,600	903,800	1,006,000	45.2	102,200	226,200	138,700
1968	--	3,478,000	226,200	698,100	924,300	1,006,000	36.1	81,700	226,200	220,400
1969	--	3,478,000	226,200	719,200	945,400	1,006,000	26.8	60,600	226,200	281,000

[a] Interest earned by surplus not included
[b] Revenue required before completion of treatment facilities
[c] Interest during construction

Notes:
Debt service on an assumed amount of $2,500,000 of general obligation bonds is not included in the above costs. These bonds would be retired by payments from general property taxes.

bonds would be payable from general property taxes. The effect would be to raise the tax rate about $3.00 per $1,000 of assessed valuation, based on a total assessed valuation of $58,720,000 for the Village.

Funds derived from the general obligation bonds would be used to defray the preliminary costs, such as purchase of land, legal administrative and engineering fees, borings, surveys, etc., and for the initial construction costs for revisions to the sewerage system, pumping station, and other early work.

If the amount of general obligation bonds sold is less than $2,500,000, the required revenue from sewage service charges as shown in Tables 14 and 15 would be increased accordingly.

Annual costs and revenues in the tables have been shown to and including the year 1969, which represents five years of full operation of the facilities. At that time, or sooner if necessary, a review of operating costs and revenues should be made, and the revenues adjusted to cover operating costs, debt service, and a minimum 25 percent coverage of the debt service for the next chosen period.

Tables 14 and 15 differ only in method of collecting revenue. In accordance with the method shown in Table 14, the collection of the full amount of sewage service charges would commence immediately upon authorization from the voters to proceed with the project. This method would greatly reduce the amount of revenue bonds to be sold and thereby reduce the fixed yearly payment for debt service for these revenue bonds.

In the method shown in Table 15, sewage service charges would be minor until the full amount of revenue bonds had been sold and the plant constructed and placed in operation. Under this method, the full amount of revenue bonds would be required to be sold.

Table 16 shows the bond issues which would be required based on the sale of $2,500,000 worth of general obligation bonds. The proposed issuance of revenue bonds is based on the requirements of Table 15, which requires the maximum bond issue. If the plan shown in Table 14 is adopted, the amounts of the revenue bond issues would be reduced as noted in the footnotes for Table 16.

We recommend that the method of assessing sewage service charges shown in Table 14 be adopted.

The costs represent construction and operating expenses necessary for present flows and strengths of wastes. Before final design of the works is started, definite commitments should be obtained from the industries regarding exact flows and waste characteristics to be planned for. Process changes may be made which will reduce the quantities and strengths of the wastes, and thus somewhat reduce the capital and operating costs shown in the tables.

Table 16. Bonding Requirements based on
$2,500,000 General Obligation Bond Issue

Year	Description of Item	Capital Cost	General Obligation Bond Issue	Revenue Bond Issue
1961-1962	Sewer system alterations	$ 360,000		
	Purchase of land	708,000		
	Engineering (design), fiscal, legal and administrative expense	421,000		
	Sub-Total	$1,489,000	$1,489,000	--
1963	Initial construction, contingencies, and engineering expense	$1,811,000	$1,011,000	$ 800,000[1]
1964	Remaining construction contingencies, and engineering expense	$2,678,000		$2,678,000[2]
	Total	$5,978,000	$2,500,000	$3,478,000[2]

(1) Reduced to zero if Table 14 plan is adopted.
(2) Reduced to $1,789,000 if Table 14 plan is adopted.

Sources of Revenue.

The needed revenue to defray the annual costs of constructing and operating the sewerage facilities must be derived either from general property taxes, sewage service charges or a combination of both methods.

As explained previously, we have based our studies on the sale of $2,500,000 in general obligation bonds as presently proposed by Village authorities, the remaining costs to be met by the sale of revenue bonds.

Payments necessary to retire the general obligation bonds would be made from the general property tax.

Operating costs and the debt service for the revenue bonds would be paid by sewage service charges levied against those contributing wastes to the sewerage system. The three classes of contributors required to pay sewage service charges would be industrial, commercial, and domestic.

In the case of Monsanto Village, the sewage flow from commercial and domestic contributors is negligible when compared to the contributions from the industries.

Bases for Sewage Service Charges.

Sewage service charges are commonly based on a combination of flow and the various characteristics of the wastes which have a direct bearing on the costs of treatment, such as suspended solids and BOD.

In the case of the Monsanto Village wastes, additional characteristics which increase the costs of treatment or should be accounted for in a sewage service charge are:

Total acidity
Phenol
Copper
Zinc

In arriving at an equitable basis for sewage service charges, the capital costs were first allocated between the phenol-acid wastes system (contributed by Monsanto, Mobil Oil, and Sterling Steel*) and the metal-bearing wastes system. As the recommended plan includes the treatment of the phenol-acid wastes separately from the other wastes, the division of costs is readily apparent. The phenol-acid wastes would be treated in the activated sludge portion of the plant and the other wastes in the primary sedimentation portion of the plant as indicated on Fig. 6.

This allocation of costs is shown in Tables 17 and 18 which list the breakdown of construction and annual costs, respectively.

Having the annual costs allocated between the phenol-acid bearing wastes system and the metal bearing wastes system, the next step was the computation of costs for each portion of the wastes treatment plant chargeable to the waste characteristics.

NOTE: - Wastes from Sterling Steel do not contain phenol or acid but are included with such wastes because of location on sewer system. Also, the volume of the Sterling Steel wastes does not justify segregation.

Table 17. Plan III - Recommended Plan

Allocation of Construction Costs Between Phenol-Acid Bearing Wastes and Metal Bearing Wastes

Item	Estimated Construction Cost		
	Proportion for Phenol-Acid Wastes	Proportion for Metal Wastes	Total
Flow measuring devices in sewerage system	$ 16,000	$ 38,000	$ 54,000
Separation of Wastes	--	275,000	275,000
Pumping Station Improvements	80,000	90,000	170,000
Flow Measurement in Plant	20,000	14,000	34,000
Primary Clarifiers	280,000	280,000	560,000
Neutralizing Tanks	115,000	--	115,000
Aeration & Final Settling Tanks	1,410,000	--	1,410,000
Lime Storage and Feed Building	300,000	--	300,000
Emergency Storage Basin	115,000	--	115,000
Oil and Scum Storage Tank	5,000	5,000	10,000
Sludge Pumping Facilities	28,000	28,000	56,000
Sludge Lagoons	20,000	105,000	125,000
Outside Piping and Yard Work	485,000	170,000	655,000
Maintenance and Garage Building	70,000	40,000	110,000
Administration and Laboratory Bldg.	90,000	40,000	130,000
Railroad Siding	75,000	--	75,000
Total Estimated Construction Costs	$3,109,000	$1,085,000	$4,194,000

Table 18. Plan III - Recommended Plan

Allocation of Annual Costs Between
Phenol-Acid Bearing Wastes and
Metal Bearing Wastes

Item	Estimated Annual Cost		
	Proportion for Phenol-Acid Wastes	Proportion for all other wastes	Total
Fixed Costs			
Debt Service			
5.0% 30-year Revenue Bonds for $1,789,000	$ 86,500	$ 30,000	$116,500
Operating Costs			
Salaries	155,000	72,000	227,000
Administration and Insurance	46,000	20,500	66,500
Maintenance	49,000	22,000	71,000
Chemicals	150,000	--	150,000
Power	106,500	19,000	125,500
Annual Cost	$593,000	$163,500	$756,500

NOTES:

(1) Debt service for $2,500,000 of general obligation bonds is not included in the above annual costs. This would amount to approximately $176,000 per year to be raised from real estate taxes.

(2) Operating costs are for the first full year of treatment plant operation.

(3) Administration and Insurance Costs include an allowance for annual bond indenture consulting services.

Table 19 lists the expected yearly quantities of waste materials to be used in setting sewage service charge rates. This table was derived from the results of the flow measurement and sampling programs previously described.

Table 20 lists the percentages and annual costs chargeable to flow and waste characteristics for each of the systems. These figures were derived by taking the estimated cost of each of the plant units in turn and estimating the proportion chargeable to each waste characteristic.

Having the estimated annual amounts of each waste constituent and the estimated annual cost chargeable to that constituent, the annual cost per unit constituent was then determined. These unit costs in turn were increased by the necessary ratio to obtain the yearly revenue necessary to obtain the minimum 25 percent coverage required for the revenue bonds. These unit charges and revenues are shown in Table 21.

The flows, amounts of each waste constituent, and anticipated revenues from the major industries are listed in Table 22.

It would seem logical that industries contributing strictly domestic wastes, commercial establishments, and domestic contributors should pay sewage service charges on

Table 19. Estimated Quantities of Waste Materials to be Treated

Phenol-Acid Wastes System

Industry	Flow		Suspended Solids		Zinc		Copper		BOD		Phenol		Acidity	
	Av. daily mgd.	Total annual mil.gal.	Av. daily tons/day	Total annual tons	Av. daily tons/day	Total annual tons	Av. daily tons/day	Total annual tons	Av. daily tons/day	Total annual tons	Av. daily tons/day	Total annual tons	Av. daily tons/day	Total annual tons
Mobil Oil Co.	1.51	551	1.97	719	--	--	--	--	1.85	675	0.18	66	--	--
Monsanto Chemical Co.	24.54	8,957	6.04	2,205	--	--	--	--	15.10	5,512	4.1	1,497	62.55	22,831
Others	0.15	55	0.06	22	--	--	--	--	0.05	18	--	--	--	--
Totals	26.20	9,563	8.07	2,946	--	--	--	--	17.00	6,205	4.28	1,563	62.55	22,831
Metallic Wastes System														
American Zinc Co.	5.42	1,978	1.843	673	0.728	266	--	--	--	--	--	--	--	--
Darling Fertilizer Co.	0.04	15	0.085	31	--	--	--	--	--	--	--	--	--	--
Lewin Metals Co.	2.98	1,088	0.805	294	0.212	77	0.228	83	--	--	--	--	--	--
Midwest Rubber Co.	3.60	1,314	6.320	2,307	0.495	181	--	--	--	--	--	--	--	--
Totals	12.04	4,395	9.053	3,305	1.435	524	0.228	83						

Table 20. Allocation of Costs Chargeable to Flow and Waste Characteristics

Item	Total Amount	Chargeable To: Flow Amount	Flow %	Susp. Solids + Cu + Zn Amount	Susp. Solids + Cu + Zn %	BOD + Phenol Amount	BOD + Phenol %	Acidity Amount	Acidity %
Phenol-Acid Bearing Wastes System									
Estimated Construction Cost	$3,109,000	$1,156,500	37.2	$133,700	4.3	$1,165,900	37.5	$652,900	21.0
Estimated 1965 Annual Cost	593,000	121,000	20.4	52,200	8.8	166,000	28.0	253,800	42.8
Estimated 1969 Annual Cost	655,000	133,600	20.4	57,600	8.8	183,400	28.0	280,400	42.8
Metal Bearing Wastes System									
Estimated Construction Cost	1,085,000	857,100	79.0	227,900	21.0	--	--	--	--
Estimated 1965 Annual Cost	163,500	101,700	62.2	61,800	37.8	--	--	--	--
Estimated 1969 Annual Cost	180,500	112,300	62.2	68,200	37.8	--	--	--	--

Table 21. Unit Charges for Waste Characteristics

Waste Characteristic	Annual No. of Units	Estimated Annual Cost	Unit Cost	Required Annual Revenue*	Required Unit Charge*
Phenol-Acid Wastes					
Flow	9,563 mil.gal	$133,600	$13.97	$138,600	$14.49
Suspended Solids	2,946 tons	57,600	19.58	59,900	20.32
BOD & Phenol	7,768 tons	183,400	23.61	190,300	24,50
Acidity	22,831 tons	280,400	12.28	290,900	12.74
Metallic Wastes					
Flow	4,395 mil.gal.	112,300	25.55	116,500	26.51
Suspended Solids, Copper & Zinc	3,912 tons	68,200	17.43	70,800	18.09
TOTALS		$835,500		$867,000	

*Adjusted to account for debt service coverage.

Table 22. Anticipated Revenue from Industries

Phenol-Acid System

Contributor	Flow				Suspended solids plus Zn plus Cu.				Phenol plus BOD				Acidity				Total Revenue
	Av. Daily mgd.	Total annual mg.	Unit charge	Annual charge	Daily tons/day	Annual tons	Unit charge	Annual charge	Daily tons/day	Annual tons	Unit charge	Annual charge	Daily tons/day	Annual tons	Unit charge	Annual charge	Dollars
Socony Mobil Oil Co.	1.51	551	$ 14.49	$ 8,000	1.97	719	$ 20.32	$ 14,600	2.03	741	$ 24.50	$ 18,200	--	--	$ 12.74	$ --	$ 40,800
Monsanto Chemical Co.	24.54	8,957	14.49	129,800	6.04	2,205	20.32	44,800	19.20	7,009	24.50	171,700	62.55	22,831	12.74	290,000	637,200
Others	0.15	55	14.49	800	0.06	22	20.32	500	0.05	18	24.50	400	--	--	12.74	--	1,700
Totals	26.20	9,563	--	$138,600	8.07	2,946	--	$ 59,900	21.28	7,768	--	$190,300	62.55	22,831	--	$290,000	$679,700
Metal Wastes System																	
American Zinc Co.	5.42	1,978	$ 26.51	$ 52,400	2.571	939	18.09	$ 17,000	--	--	--	--	--	--	--	--	$ 69,400
Darling Fertilizer Co.	0.04	15	26.51	400	0.085	31	18.09	600	--	--	--	--	--	--	--	--	1,000
Lewin-Metal Co.	2.98	1,088	26.51	28,900	1.245	454	18.09	8,200	--	--	--	--	--	--	--	--	37,100
Midwest Rubber Co.	3.60	1,314	26.51	34,800	6.815	2,488	18.09	45,000	--	---	--	--	--	--	--	--	79,300
Totals	12.04	4,395	--	$116,500	10.516	3,912	--	$ 70,800	--	--	--	--	--	--		--	$187,300

the basis of flow alone. This would obviate the necessity for periodic sampling and analyses of the wastes. The charges would be based on the amount of water consumed which could be obtained from the water bills or the charge could be a percentage of the amount paid for water. Either method of billing would be satisfactory and equitable.

We recommend that the initial charge for industries contributing only domestic sewage, commercial establishments, and domestic contributors be at the rate of $0.06 per 1,000 gal. of sewage. For convenience, the quantity of sewage charged for would be based on water meter readings. It is customary to allow a discount for prompt payment for this class of contributors in which case the rate could be set at $0.08 per 1,000 gal. with a 25 percent discount if paid in 10 days.

The estimated total annual cost of the waste treatment system for a family of four living in a house with an assessed valuation of $4,000 would be as follows:

Increase in general property tax 4,000/1000 x $3.00 =	$12.00
Sewage service charge 4 x 100 x 365/1000 x $0.06	8.76
Total	$20.76

The above-suggested charge rates for contributors to the system are based on the issuance of $2,500,000 in general obligation bonds to be paid for out of general property taxes. If a lesser amount of general obligation bonds are sold, requiring a larger amount of revenue bonds, the recommended sewage service charge rates would, of necessity, be increased.

The recommended charge rates will no doubt be changed by the time the actual initial rates are fixed, but should serve as a basis for the establishment of the initial legal rates. After the plant is in operation, it will be necessary to revise the rates at intervals of one, two, or perhaps five years, as experience dictates.

GAGING, SAMPLING AND CHEMICAL ANALYSES

General.

In instances where industrial waste waters are accepted by Municipalities, Sanitary Districts, or Authorities for treatment, it is common practice to assess charges for treatment on the basis of the volume and the chemical character of the wastes. This is the most equitable method of amortizing capital costs and defraying operating expenses, since industrial waste waters vary greatly in the amount and nature of the pollutional matter which they contain. When it becomes necessary to finance waste treatment facilities, in part or entirely, by issuance of revenue bonds, it usually is necessary to establish a system of waste treatment charges that is considered equitable in order to make the bonds attractive to the buyer. This means provisions must be made for accurate gaging or estimation of all waste flows, for continuous sampling of all major flows to provide composited samples, and chemical analyses to ascertain the contributions from each source.

Gaging and Sampling Stations.

It is proposed to construct gaging and sampling stations for waste waters from American Zinc, Lewin Mathes, Midwest Rubber, Mobil Oil, and Sterling Steel. It appears impractical to provide such facilities for Darling Fertilizer because of the small flow involved and, for Monsanto Chemical, because of its many sewer connections and the relative ease of estimating its flow by difference.

Under the proposed plan of segregating the waste waters into two streams for separate treatment, the wastes containing phenol and mineral acids plus some minor flows will be segregated for separate treatment. This stream will include the wastes from Mobil Oil, Monsanto Chemical, Sterling Steel, and all residential areas. The flow from Mobil Oil and the flow from Sterling Steel and residential areas will be gaged by means of two stations. Since the total flow of phenol-acid wastes will be measured at the treatment plant site, the contributions from Monsanto Chemical can be obtained by difference. Care must be taken to avoid including storm flows, however.

The waste water flows to the sewer system handling metal bearing wastes will be gaged at American Zinc, Lewin Mathes, and Midwest Rubber. The flow from Darling Fertilizer will be estimated from water meter records.

Each of the gaging stations should be equipped with automatic sampling devices that will take samples continuously or at frequent intervals in proportion to the flow or allow composited samples to be prepared, therefrom. These samplers should be designed to operate continuously, seven days per week, if desired.

Continuously operated, automatic samplers should be provided at the waste treatment plants to obtain samples of the total flow to each plant. These will serve as a guide for operating the treatment units, and the samples of combined phenol-acid wastes will serve as a basis for calculating the contributions by Monsanto Chemical Co.

Continuously operated, automatic samplers should be provided on the effluent lines from each of the waste treatment plants in order to measure the efficacy of treatment provided by each plant and to provide a record of the quality of the effluents as discharged to the Mississippi River.

Chemical Analyses.

All analyses should be conducted in accordance with procedures outlined in the latest available edition of Standard Methods.[1]

The combined wastes entering each treatment plant and the effluent from each should be analyzed daily. The wastes from all contributors should be analyzed at least three times weekly and on a rotating basis so that each day of the week is included in any three week period. The best plan is to collect samples at all locations seven days per week and let the engineer in charge of waste treatment arrange a schedule for analyzing the samples.

Metal Bearing Wastes - The purpose of treating the metal bearing wastes before discharge to the Mississippi River is to remove floating matter, suspended solids, copper and zinc. Therefore, in addition to flow considerations, these items should be considered in assessing charges for treating

(1) Standard Methods for the Examination of Water and Waste Water, American Public Health Association, New York, N.Y.

the wastes from each contributor. The following comments are offered as a guide to the specific analyses to be run.

<u>Floating Matter</u> - It is extremely difficult to obtain representative samples of floating matter except by manual sampling. Because of the cost of labor for manual sampling and the minor aspects of handling such materials, including possibilities of salvage, it is recommended that no attempt be made to measure floating matter, unless experience dictates otherwise.

<u>Suspended Solids</u> - It is recommended that all samples be adjusted into a pH range of 7 to 8 before measuring suspended solids. This will ensure an equitable basis of charges.

<u>Copper and Zinc</u> - Copper and zinc should be reported as copper ion (Cu^{++}) and zinc ion (Zn^{++}). Although both copper and zinc will be measured in the suspended solids, it is considered desirable to apportion part of the cost of treatment to them, to encourage rigid control at the source.

<u>Phenol-Acid Bearing Wastes</u> - The purpose of treating these wastes is to remove floating matter, suspended matter and phenolic compounds. Since phenolic compounds will be removed by a biological process, the BOD of the wastes is also a consideration. The following recommendations are made concerning the analyses to be run.

<u>Floating Matter</u> - The same comments made under Metal Bearing wastes apply.

<u>Suspended Solids</u> - It is anticipated that the phenol-acid bearing wastes will arrive at the treatment plant site in an acid condition most of the time. The treatment plan provides for neutralizing the mineral acidity, by adding lime to adjust the pH in the range of 4 to 5, at the main pumping station. Thus, the wastes delivered to the primary clarifiers will have a pH of 4 to 5 and only an amount of suspended solids that can exist in that pH range. For that reason, it is recommended that all wastes included in the sewer handling phenol-acid wastes be adjusted to a pH between 4 and 5 prior to being analyzed for suspended solids. This will assure an equitable basis of charging for handling the sludge removed by the primary clarifiers.

<u>Mineral and Total Acidity</u> - Mineral acidity determinations should be made in order to evaluate the amount of lime required for its neutralization at the pumping station and to serve as a basis of control measures at the source, if found necessary. Total acidity determinations should be made on the combined waste flow to serve as the basis for assessing charges for neutralization of the wastes.

<u>BOD</u> - The cost of operation of the activated sludge units will depend to a great extent upon the oxygen requirements as measured by BOD.

Phenol - Although phenolic-type compounds will be measured to a considerable extent by the BOD determination, the activated sludge method of waste treatment is being employed solely for their destruction. Therefore, it will be necessary to maintain records of the phenolic materials in the influent and effluent of the plant. In addition, it is considered desirable to apportion part of the cost of treatment to phenols to encourage as rigid control of phenol, as possible, at the source.

Final Effluents - All analyses should be made on the effluents as they occur. The effluent from the units treating metal bearing wastes should be analyzed for:

1. Suspended Solids
2. Copper
3. Zinc

The effluent from the activated sludge units should be analyzed for:

1. Suspended Solids
2. BOD
3. Phenols

PRECAUTIONS BEFORE DESIGN OF THE FACILITIES

Before the final design of the facilities is commenced, the following should be accomplished:

1. Purchase the necessary land for the waste treatment facilities.

2. Obtain firm commitments from the industries regarding the flows and constituents of the wastes to be discharged to the system, taking into consideration any expected process changes to reduce the amount of sewage service charges.

3. Obtain a decision from the Corps of Engineers regarding the changes in the pumping station facilities. This is very important as the cost estimates in this report are based on revision of the existing pumping station for use with the proposed waste treatment plant. If it should be necessary for the Village to construct a new pumping station, the estimated cost of the work should be increased considerably.

ACKNOWLEDGMENTS

The survey upon which this report is based involved the help and cooperation of a great many people and organizations. We wish to express our appreciation to Mayor Leo Sauget, the Village Board, and Mr. Joseph W. Goldenberg, Village Engineer, for their cooperation in supplying materials and manpower to aid in the sampling program; to representatives of Monsanto Chemical Company who provided laboratory space, sampling and gaging equipment; and all other representatives of industrial firms who aided us with information and materials related to their specific problems.

We wish to extend special thanks to Mr. H.D. Tomlinson for his part in conducting the field studies, involving sampling and gaging of the waste flows and initiation of the activated sludge studies. Also, to Dr. S. G. Grigoropoulos for relieving Mr. Tomlinson and bringing the activated sludge studies to a successful conclusion.

We are deeply indebted to Mr. Paul Hodges of Monsanto Chemical Company for sharing with us his knowledge and equipment for making the lithium chloride tests upon which many of the flow data are based.

Finally, we wish to express our appreciation to Mr. Klassen and his associates of the State Sanitary Water Board for their timely and prompt consideration of requests for information and proposals.

Respectfully submitted,

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APPENDIX A

WASTE WATER FLOWS

Table 3. Estimates of Future Waste Water Flows, Mgd.

	1960	1965	1970	1980
Phenol Bearing Wastes				
Mobil Oil	1.51	2.30	2.50	2.90
Monsanto Chemical	24.60	24.60	24.60	24.60
Sterling Steel	0.01	0.01	0.01	0.01
Others	0.04	0.05	0.07	0.08
Totals	26.16	26.96	27.18	27.59
Metal Bearing Wastes				
American Zinc	5.42	1.00	1.20	1.50
Darling Fertilizer	0.04	0.04	0.05	0.06
Lewin Mathes	2.98	3.00	4.00	5.00
Midwest-Rubber	3.60	0.50	0.60	0.80
Totals	12.04	4.54	5.85	7.36
New Business	0.00	1.00	3.50	7.00
Grand Totals	38.20	32.50	36.50	42.00

Water conservation practices could have a significant effect on the volume of metal bearing wastes to be handled. It is possible that total flows might be reduced to 4.6 mgd. and that this might not exceed 7.4 mgd. by the year 1980. Before final design of waste treatment facilities are made, firm commitments on waste flows should be made from all industries that can reduce water volumes appreciably.

It is to be anticipated that the development of waste treatment facilities at Monsanto Village will make it a favorable location for other "wet" industries. It is difficult to predict how great such industrial expansion might be. For purposes of making cost estimates, it has been assumed that the volume of waste waters to be accommodated from new industries will be 1.0 mgd. in 1965, 3.5 mgd. in 1970, and 7.0 mgd. in 1980. Thus, it is predicted that even with water conservation practices, the waste flows will reach present levels by about 1975. It would seem reasonable to assume that wastes from new industries would be free of phenols and, therefore, would be included with the metal bearing wastes for treatment.

CHARACTER OF WASTE WATERS

Concurrent with the gaging program conducted to determine the volume of waste waters contributed by each industry, samples of wastes were collected for chemical and biological analyses. In all cases where continuous flow records were obtained, a continuous type of sampler was used that withdrew waste water from the sewer at a uniform rate and discharged into separate receivers each hour. Thus, at the end of a 24-hour period, 24 hourly samples were available. From these, three 8-hour composited samples, corresponding to the three daily work shifts, were prepared on the basis of the flow data obtained. Certain analytical tests were made on the shift samples, by Metcalf & Eddy personnel, in the laboratories of Monsanto Chemical Company and then each sample was divided into 3 portions. One portion was preserved with chloroform, one with sulfuric acid, and one with copper sulfate. All preserved samples were shipped to Boston for detailed analysis in the laboratories of Metcalf & Eddy.

Samples were collected on at least 4 days for a total of 12 shifts, from each of the major sewers, usually over a 2-week period. Sampling was started at the Mobil Oil Company on February 16, 1960 and was completed at the American Zinc Company on June 21, 1960. Grab samples were obtained on several occasions from all sewers not sampled continuously. The samples were preserved for shipment and analyzed in the same manner as the composited shift samples.

The composited and grab samples were submitted to analysis for pH, acidity, alkalinity, suspended solids, total solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD), chromium, copper, zinc, phenol, ammonia nitrogen, organic nitrogen, and total phosphorus. In addition the samples were submitted to Warburg respirometer studies to determine their biological treatability and toxic properties. When preliminary studies showed that certain tests were not applicable, only those analyses were performed that had significance.

The results of the detailed chemical analyses are shown in pages B-1 to B-37, Appendix B. A few comments regarding these are in order.

<u>American Zinc Company</u> (Ref. pages B-1 to B-6).

The waste waters from the American Zinc Company normally have a pH value in the range of 6.0 to 7.4 and contain reserve alkalinity ranging from 60 to 310 mg./L (milligrams per liter). On occasion, and particularly during the first shift, the wastes in the East sewer are acid in character, having pH values as low as 2.6 and mineral acidities as great as 500 mg./L. The wastes in the West sewer always have a pH of 6.8 or above and alkalinity in the range of 220 to 310 mg./L. Since the flow of wastes in the West sewer is approximately 8 times that in the East sewer, there is always adequate alkalinity present to neutralize the acidity and the resulting combined flow from American Zinc Company has a favorable pH of 5 to 7.5.

The suspended solids range from 16 to 190 mg./L and are largely inorganic in nature as shown by the low volatile content.

The total solids content in the wastes carried by the West sewer showed minor variations, ranging from 755 to 1,165 mg./L. These values show only slight contamination, since well waters in the Monsanto area carry approximately 750 mg./L of naturally occurring total solids. The wastes carried by the East sewer contained total solids ranging from 760 to 14,400 mg./L showing a marked variation in pollutional load.

The BOD data obtained on American Zinc Company wastes are considered unreliable because of the toxic character of the wastes, as a result of the zinc ion content. This conclusion was born out by Warburg respirometer studies which showed the wastes were toxic to activated sludge.

The COD data obtained on the American Zinc Company wastes are considered reasonably indicative of the degree of contamination of the waste waters by organic compounds. These range from 19 to 125 mg./L in all but one instance. It was concluded, therefore, that the wastes contain relatively minor amounts of organic pollutants.

The wastes were found to contain appreciable amounts of zinc and smaller amounts of copper. The level of zinc in the East sewer was found to range from 23 to 500 mg./L in 8-hour composited samples, with maximum values always found on the first shift. The level of zinc in the West sewer was found to range from 7 to 32 mg./L in 8-hour composited samples. The copper content of the wastes in the West sewer were found to be less than 1.0 mg./L but the wastes in the East sewer showed values ranging from 0.6 to 12.0 mg./L.

Preliminary analyses for chromium, phenol, nitrogen and phosphorus showed these items to be of no concern in American Zinc Company wastes.

The results of the survey at American Zinc Company showed that wastes carried in the West sewer, amounting to about 4.8 mgd., were lightly contaminated cooling water, and suggestions were made to representatives of the American Zinc Company that consideration be given to water conservation practices to reduce the volume of wastes discharged to the sewer. Suggestions were also made as to the possibility of reducing the losses of zinc contained in the wastes carried by the East sewer.

Darling Fertilizer Company (Ref. pages B-7 and B-8).

The waste waters from the Darling Fertilizer Company are carried in two sewers. Those carried by the North sewer were found to be acid at all times, having pH values in the range of 2.9 to 3.3 and mineral acidities varying from 590 to 1,110 mg./L. The suspended solids, total solids, and total phosphorus values were considerably greater than would be expected from use of the public water for sanitary purposes. The BOD and COD data indicated that the pollution was largely inorganic in character and it was concluded that the unusual nature of the wastes was a result of losses of phosphate fertilizers to the sewer. Because of the small volume of wastes involved and the possible beneficial effects of the phosphorus contained in the wastes with regards biological treatment processes, an extensive sampling program was not conducted.

The waste waters carried in the East sewer were found to have the characteristics of extremely dilute domestic sewage except for the abnormally high values for nitrogen and phosphorus which were found on occasion. This was attributed to fertilizing matter from the plant.

<u>Lewin Mathes Company</u> (Ref. pages B-9 to B-18).

Mississippi Avenue Sewer - The waste waters carried in this sewer were found to correspond to weak sanitary sewage in all respects, except that they carried significant amounts of chromium, copper and zinc. In general, chromium levels were less than 1.0 mg./L, copper ranged from 1.0 to 8.6 mg./L, and zinc ranged from 0.4 to 14 mg./L.

Control Building Sewer - The waste waters from this sewer varied greatly in pH, ranging from 2.5 to 6.8. Mineral acidity varied from zero to 800 mg./L, while alkalinity varied from zero to a maximum of 90 mg./L. The other major contaminants in the waste stream were copper and zinc. Copper levels ranged from 5 to 240 mg./L and zinc from 33 to 200 mg./L. The BOD data were considered unreliable because of the toxic effects of the copper and zinc. Because of the unusual amounts of metal ions in this waste stream, the matter was drawn to the attention of officials of Lewin Mathes Company with suggestions that the more concentrated solutions discharged to the sewer might be isolated for recovery of metals.

Village Lift Station Sewer - The waste waters in this sewer were quite like a weak domestic sewage in most respects. BOD values, however, were found to be quite low. This was attributed to the presence of appreciable amounts of chromium, copper, and zinc. Chromium values varied from less than 0.5 to 12.1 mg./L, copper ranged from 2.0 to 15.2 mg./L, and zinc from 0.8 to 5.0 mg./L in 8-hour composites.

24-In. Storm Sewer - The samples collected from this sewer were all found to be contaminated with small amounts of copper and zinc. Otherwise, the waste water was quite typical of waste cooling water.

Special 5-Hour Composited Samples - Following completion of the waste water survey at Lewin Mathes Company on May 4, 1960, we were informed by officials of the company that they were discontinuing operations related to the manufacture of brass products. This, of course, raised a question concerning the reliability of the data we had obtained in predicting Lewin Mathes Company's contributions to the village sewers under the new conditions. In order to determine whether a second sampling program was necessary, a series of three 5-hour composited samples was collected from the three main sewers. The samples were submitted to limited chemical analysis, including copper and zinc, and the results are presented on pages B-11, B-14, and B-17. These data demonstrate that the copper and zinc content of the various waste streams was quite the same as during the original survey. It was concluded that a resurvey was not required.

Midwest Rubber Company (B-19 and B-20).

The waste waters of Midwest Rubber Company are quite like a strong domestic sewage, except that they contain appreciable amounts of zinc, ranging from 6 to 45 mg./L. BOD values were found to be relatively low which reflects the toxic properties of the zinc ion on that test. This is demonstrated by the ratio of BOD to COD. In all cases where zinc was present in excess of 20 mg./L, the ratio was 0.2 or less. In the instances where zinc was present at levels of 15 and 6 mg./L, the ratios were 0.27 and 0.31, respectively.

Midwest wastes contain high concentrations of suspended solids. A good deal of this is due to "crumbs" of rubber which reach the sewers. On occasion, large pieces of rubber collected on the bubbler tube used to measure elevation of water in the sewer and interfered with its operation. The matter of unusual, and apparently unnecessary, losses of rubber to the sewer was brought to the attention of officials of the company with suggestions that corrections be made.

Mobil Oil Company (B-21 to B-23).

The wastes of the Mobil Oil Company are unusual in several respects. They are ordinarily alkaline in character with pH values ranging from 8.7 to 10.2. Although the major part of the wastes flow through API-type separators for the removal of oil, the combined wastes contain suspended solids in amounts ranging from 350 to 830 mg./L. Much of these solids, however, consist of waste calcium carbonate and magnesium hydroxide originating from water softening operations. Although these materials may be detrimental to the sewer serving Mobil Oil, they serve a useful purpose further downstream by neutralizing acid wastes discharged to the sewer. Because of this beneficial function, they should not be excluded from the sewer and care should be taken to avoid making charges against Mobil Oil for discharging these beneficial materials.

The Mobil Oil Company wastes are unusual in that they contain relatively high concentrations of ammonia nitrogen and phenols. The ammonia nitrogen is considered beneficial as it would supply an important nutrient for destruction of phenols by biological means. The phenols were found to vary widely, ranging from 14 to 385 mg./L in 8-hour composited samples. The BOD of the wastes varied widely, also, values from 165 to 1,530 mg./L were found. There was an excellent correlation between phenol content and BOD.

The high phenol and BOD values observed in Mobil Oil wastes were of some concern. A study of the data disclosed that the high values always occurred during the first shift. At a conference held with Mobil Oil officials, it was learned that certain residual liquors were dropped during the first shift of operations on occasional days. Fortunately, the sampling program detected the effects of the practice and a plan of correcting the situation was evolved at the conference.

In order to check on the efficacy of the phenol control practice at Mobil Oil, a sampling machine was reinstalled and shift samples collected on six days over the period of May 18 to June 2, 1960. The samples were analyzed solely for phenols and the results are given on page B-23. These data show that the high concentrations of phenols had been effectively controlled and indicate that the range of values to be expected is from 11 to 29 mg./L.

Monsanto Chemical Company (B-24 to B-36).

The Monsanto Chemical Company waste waters are, in general, acid in character with pH values in the range of 2 to 3 and mineral acidity ranging from 100 to 1,000 mg./L, or more on occasion. Suspended solids in general are quite low due to the acid conditions but a considerable increase occurs on neutralization of the wastes to pH 7 to 8. The usual level of suspended solids in neutralized samples is in the range of 60 to 100 mg./L. Total solids vary widely, ranging from values as low as 425 mg./L in the East Storm sewer to as high as 13,635 mg./L in the West Storm sewer. The major flow, carried in the 24-in. and 30-in. Main Area sewers, however, had total solids in the range of 1,600 to 3,800 mg./L.

The BOD of the Monsanto wastes was found to be relatively low in comparison to the COD values. This is probably due, in part, to the biologically inert character of some of the organic components, but most waste streams contained significant amounts of copper and zinc which could have prevented the normal exertion of BOD in the usual 5-day incubation period.

Phenols were found to be present in the waste waters from all six sewers. The concentration varied markedly, however. In the 24-in. and 30-in. sewers serving the Main Area and carrying approximately 90 percent of the total Monsanto flow, concentrations ranged from 10 to 56 mg./L in the 24-in. sewer and from 15 to 130 mg./L in the 30-in. sewer. Phenol levels were generally below 5 mg./L in the East Main sewer, varied from 5.5 to 22 mg./L in the East Storm sewer, from 5 to 18 mg./L in the West Main sewer, and from 13 to 32 mg./L in West Storm sewer.

Phosphorus and ammonia nitrogen values were found to be highly variable in the wastes. The amount of phosphorus is in excess of needs for biological treatment and the amount of nitrogen is adequate to supply the needs up to about 300 mg./L of BOD. On the basis of the COD data, it is predicted that the actual 5-day BOD of Monsanto Chemical Company wastes will be considerably less than 300 mg./L.

Sterling Steel Casting Company (B-37).

The waste waters from Sterling Steel were found to be typical of sanitary wastes and it was concluded that their wastes should be considered as such in terms of treatment requirements.

Oil and Grease.

Considerable amounts of heavy oils and grease occur in the waste waters of Monsanto Village. The sampling program was not designed to give a quantitative evaluation of the amount of grease. It was considered that oil and grease can never be completely controlled at the source, therefore, treatment plant design must include facilities for removal and disposal of such materials.

In the course of the survey, it was noted that large amounts of grease and oil originated from Midwest Rubber Company. This matter was called to the attention of officials of that company, for the purpose of insuring that no unnecessary losses were occurring.

AMERICAN ZINC COMPANY

Waste Water Flows

15-In. Sewer (East Sewer)

Source of Waste Water	Gpm.	Gpd.
Casting	62.5	90,000
Fume Scrubber & Filter	7.5	10,800
Furnace Door	10.0	14,400
Compressors & Vacuum Pumps	200	288,000
Specialty Plant	35	50,000
Boiler Blow Down		
High Pressure		240
Low Pressure		420
City Water		176,000
Total		629,860

21-In. Sewer (West Sewer)

Source of Waste Water	Gpm.	Gpd.
Rectifiers[1]	200	288,000
Acid Evaporators[2]	2,675	3,850,000
Neutral Evaporators[3]	450	648,000
Strontium Wash	--	2,000
Total		4,788,000
Grand Total		5,417,860

(1) Measured volumetrically.
(2) Calculated by temperature change.
(3) Measured by orifice.

DARLING FERTILIZER COMPANY

Water Consumption from Water Bills

Month	Cu. Ft.	Gpm.	Gpd.
January 1959	239,900	40	57,500
February	219,300	40	58,000
March	213,800	36	51,500
April	264,500	45	65,500
May	231,700	39	56,000
June	192,400	33	47,500
July	177,100	30	42,500
August	160,500	27	38,500
September	102,200	18	25,500
October	109,600	18	26,500
November	132,700	23	33,000
December	130,100	22	31,500
January 1960	121,300	20	29,000
February	94,400	17	25,000
	Average	29	42,000

LEWIN MATHES COMPANY

Waste Water Flows - Mississippi Avenue Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total Flow, mgd.
	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	
1960	Gpm.				Gpm.				Gpm.				
April 11-12	670	715	700	0.336	715	915	850	0.408	790	900	820	0.394	1.14
12-13	660	835	740	0.356	620	850	660	0.316	850	960	880	0.422	1.09
13-14	810	850	840	0.403	790	920	830	0.398	840	920	870	0.418	1.22
14-15	840	980	900	0.431	840	1020	900	0.431	850	900	870	0.418	1.28
18-19	990	1150	1020	0.490	940	1040	960	0.460	900	980	920	0.441	1.39
19-20	960	1090	1030	0.494	1040	1110	1100	0.527	1110	1150	1120	0.537	1.56
21-22	1130	1150	1140	0.547	1020	1080	1040	0.499	1020	1170	1100	0.527	1.57
											Average		1.32

Minimum and Maximum values underlined.

LEWIN-MATHES COMPANY

Waste Water Flows - Control Building Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total Flow, mgd.
1960	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	
	------Gpm.-----				------Gpm.-----				------Gpm.-----				
April 15-16	370	400	380	0.182	380	390	380	0.182	360	390	380	0.182	0.546
18-19	345	415	390	0.187	345	345	345	0.165	335	350	340	0.163	0.515
19-20	350	370	360	0.172	345	360	350	0.168	300	360	340	0.163	0.503
21-22	380	410	390	0.187	260	380	300	0.144	240	360	290	0.139	0.470
25-26	330	415	360	0.172	350	360	350	0.168	260	350	310	0.149	0.489
26-27	370	400	380	0.182	260	360	330	0.158	210	310	250	0.120	0.460
27-28	350	380	360	0.172	290	370	340	0.163	210	280	250	0.120	0.455
28-29	370	415	390	0.187	300	420	360	0.172	230	290	270	0.130	0.489
29-30	330	370	350	0.168	350	420	380	0.182	335	345	340	0.163	0.513
												Average	0.50

Minimum and Maximum values underlined.

LEWIN MATHES COMPANY

Waste Water Flows - Village Lift Station Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total
Date	Min.	Max.	Av.	Flow per shift mil.	Min.	Max.	Av.	Flow per shift mil.	Min.	Max.	Av.	Flow per shift mil.	Flow, mgd.
1960	------Gpm.-----			gal.	------Gpm.-----			gal.	------Gpm.-----			gal.	
April 25-26	790	850	830	0.398	820	850	830	0.398	770	860	820	<u>0.413</u>	<u>1.21</u>
26-27	670	800	770	0.370	800	820	820	0.394	770	830	800	0.384	1.15
27-28	770	800	790	0.380	730	830	780	0.374	<u>570</u>	800	730	0.350	1.10
28-29	710	800	760	0.365	800	860	820	0.394	770	<u>890</u>	830	0.398	1.16
29-30	730	850	780	0.374	730	820	780	0.374	790	820	800	0.384	1.13
May 2-3	760	800	790	0.380	590	790	720	<u>0.346</u>	710	820	750	0.360	1.09
3-4	730	790	750	0.360	680	770	730	0.350	730	820	770	0.370	<u>1.08</u>
											Average		1.13

Minimum and Maximum values underlined.

LEWIN MATHES COMPANY

Waste Water Flows - 24-In. Storm Sewer

Date	Time	Flow	
		Gpm.	Gpd.
4/18/60	1:45 p.m.	20	28,800
4/19/60	9:00 a.m.	17	24,500
4/20/60	1:45 p.m.	24	34,600
4/20/60	4:15 p.m.	18.5	26,700
4/22/60	8:15 a.m.	16	23,000
4/25/60	2:45 p.m.	17	24,500
4/26/60	10:00 a.m.	20	28,800
4/26/60	12:45 p.m.	20	28,800
4/27/60	8:45 a.m.	16	23,000
4/27/60	5:00 p.m.	16	23,000
		Average	26,570

LEWIN MATHES COMPANY

SUMMARY OF WASTE WATER FLOWS

Sewer	---Gpm.----		8-Hr. Shifts, Mil. Gal		--------Mgd.---------		
	Min.	Max.	Min.	Max.	Min.	Max.	Av.
Miss. Ave.	620	1170	0.316	0.547	1.09	1.57	1.32
Control Bldg.	210	420	0.120	0.187	0.46	0.55	0.50
Lift Station	570	890	0.346	0.413	1.08	1.21	1.13
24-In. Storm	16	24	0.008	0.012	0.02	0.04	0.03
Total	1420	2500	0.790	1.159	2.65	3.37	2.98

MIDWEST RUBBER COMPANY

Waste Water Flow Data

Date	Shift No. 1				Shift No. 2				Shift No. 3				
	Min.	Max.	Av.	Total per shift mil. gal.	Min.	Max.	Av.	Total per shift mil. gal.	Min.	Max.	Av.	Total per shift, mil. gal.	Grand Total, mgd.
1960	------Gpm.-----				------Gpm.-----				------Gpm.-----				
March 21-22	2220	2300	2270	1.09	2220	2270	2250	1.08	2220	2300	2270	1.09	3.26
22-23	2220	2300	2260	1.08	2160	2220	2190	1.05	2160	2240	2180	1.05	3.18
23-24	2300	2470	2360	1.13	2320	2440	2370	1.14	2220	2320	2280	1.09	3.36
24-25	2270	2360	2320	1.11	2220	2300	2260	1.08	2220	2300	2240	1.07	3.26
28-29	2280	2360	2300	1.10	2280	2330	2300	1.10	2300	2820	2580	1.24	3.44
29-30	2680	2920	2780	1.33	2860	2990	2930	1.41	2880	2990	2930	1.41	4.15
30-31	2860	2960	2900	1.39	2900	2970	2920	1.40	2860	2920	2880	1.38	4.17
3/31 & April 1	2680	2900	2770	1.33	2660	2770	2700	1.29	2700	2940	2870	1.38	4.00
6-7	See Note No. 1				2920	2990	2980	1.43	2770	2880	2810	1.35	2.78
											Average		3.60

NOTES:

No. 1 - Flow Record unreliable on this shift.

2 - Flow during 16 hours.

3 - Flow for this shift based on average of 5 hourly flow rates.

Minimum and Maximum values underlined.

MOBIL OIL COMPANY

Waste Water Flow Data

	API Separators gpm.	Cooling Towers gpm.	Misc.* gpm.	Total gpm.	Mgd.
2/16-17/60					
Shift No. 1	635	175	85	895	
Shift No. 2	520	175	85	780	
Shift No. 3	1055	175	85	1315	
			Average	997	1.43
2/18-19/60					
Shift No. 1	635	160	95	890	
Shift No. 2	485	160	95	<u>740</u>	
Shift No. 3	485	160	95	740	
			Average	790	1.14
2/22-23/60					
Shift No. 1	1010	145	85	1240	
Shift No. 2	1145	145	85	<u>1370</u>	
Shift No. 3	950	145	85	1180	
			Average	1263	1.82
2/24-25/60					
Shift No. 1	910	135	100	1145	
Shift No. 2	1050	135	100	1285	
Shift No. 3	775	135	100	1010	
			Average	1147	1.66
			Average		1.51

*Includes sludge from water-softening plant, boiler blow-down and flume under flow.
Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Waste Water Flows - Main Area 30-In. Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total
	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Flow, mgd.
1960	-------Gpm.-----				------Gpm.-----				------Gpm.-----				
May 8-9	9600	9650	9650	4.63	9400	9600	9500	4.55	9400	9750	9600	4.60	13.78
10-11	9900	10000	9900	4.75	9750	9900	9900	4.75	9750	9900	9850	4.72	14.22
11-12	9750	9850	9850	4.73	9700	9850	9750	4.68	9700	9850	9700	4.65	14.06
12-13	9900	9950	9950	4.77	9700	9950	9850	4.72	9750	9900	9750	4.68	14.17
17-18	9900	10200	10100	4.85	9900	10100	9950	4.77	9850	9900	9850	4.72	14.34
19-20	9850	10200	10000	4.80	9850	10100	9950	4.77	9850	9900	9900	4.75	14.32
20	9700	10200	9900	4.75	9900	10000	9950	4.77	9700	9900	9750	4.68	14.20
											Average		14.16

Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Estimated Waste Water Flows -
Main Area 24-In. Sewer

Date 1960	Shift No. 1 mil. gal.	Shift No. 2 mil. gal.	Shift No. 3 mil. gal.	Total, mgd.
May 8-9	2.54	2.50	2.53	7.57
10-11	2.61	2.61	2.60	7.82
11-12	2.60	2.52	2.55	7.67
12-13	2.63	2.59	2.58	7.80
17-18	2.66	2.62	2.60	7.88
19-20	2.64	2.62	2.61	7.87
20-21	2.61	2.62	2.58	7.81
			Average	7.79

Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Waste Water Flows - North Area East Main Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total mgd.
	Min.	Max.	Av.	Total mil. gal.	Min.	Max.	Av.	Total mil. gal.	Min.	Max.	Av.	Total mil. gal.	
1960	------Gpm.-----				------Gpm.-----				------Gpm.-----				
May 25-26	804	1228	910	0.432	--	--	--	--	804	965	884	0.424	1.28
26-27	804	884	856	0.416	804	884	837	0.403	804	910	837	0.402	1.22
5/31-June 1	745	1012	884	0.424	804	1113	910	0.436	804	1398	965	0.465	1.38
1-2	856	1228	965	0.465	--	--	--	--	804	1148	910	0.436	1.35
3-4	804	1148	910	0.436	804	988	884	0.425	780	925	804	0.386	1.25
6-7	600	884	712	0.342	666	712	965	0.334	666	804	712	0.342	1.02
										Average			1.25

Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Waste Water Flows - North Area West Main Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total
	Min.	Max.	Av.	Total mil. gal.	Min.	Max.	Av.	Total mil. gal.	Min.	Max.	Av.	Total mil. gal.	mgd.
1960	------Gpm.-----				------Gpm.-----				------Gpm.-----				
May 25-26	787	810	790	0.379	--	--	--	--	765	795	777	0.373	1.13
26-27	790	810	795	0.382	754	795	777	0.373	769	795	777	0.373	1.13
5/31-June 1	790	790	790	0.379	704	777	714	0.342	704	790	735	0.352	1.07
1-2	765	816	787	0.378	--	--	--	--	735	777	744	0.356	1.10
6-7	669	756	744	0.356	714	756	723	0.347	723	735	735	0.352	1.06
11-12	744	777	756	0.363	744	744	744	0.356	735	756	744	0.356	1.08
										Average			1.10

Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Waste Water Flows - North Area West Storm Sewer

Date	Shift No. 1				Shift No. 2				Shift No. 3				Total
1960	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Min.	Max.	Av.	Flow per shift mil. gal.	Flow, mgd.
	-------Gpm.-----				-------Gpm.-----				-------Gpm.-------				
May 25	280	360	310	0.149	255	275	275	0.132	230	255	245	0.117	0.398
26	255	325	290	0.139	230	290	275	0.132	130	230	150	0.072	0.343
31	290	360	325	0.156	115	310	205	0.098	70	150	80	0.038	0.292
June 1	205	280	255	0.122	115	280	190	0.091	80	205	95	0.046	0.248
2	255	325	310	0.149	80	325	175	0.084	50	205	70	0.034	0.267
6	115	205	165	0.079	25	130	50	0.024	20	25	25	0.012	0.115
										Average			0.26

Flow measurements made by 90-deg. V-notch weir.
Minimum and Maximum values underlined.

MONSANTO CHEMICAL COMPANY

Summary of Waste Water Flows

Sewer	Gpm. Min.	Gpm. Max.	8-Hr. Shifts, Mil. Gal. Min.	8-Hr. Shifts, Mil. Gal. Max.	Mgd. Min.	Mgd. Max.	Mgd. Av.
Main Area -							
30-in.	9400	10200	4.55	4.85	13.78	14.34	14.16
24-in.	--	--	2.50	2.66	7.57	7.88	7.79
North Area -							
East Main	666	1398	0.33	0.47	1.02	1.35	1.25
East Storm	--	--	--	--	--	--	0.06
West Main	704	816	0.34	0.38	1.07	1.13	1.10
West Storm	20	360	0.01	0.16	0.12	0.40	0.26
Totals	10800	12800	7.73	8.52	23.56	25.10	24.60

STERLING STEEL COMPANY

Waste Flows

Sterling Steel has two sources of water supply:

1. East St. Louis Interurban Water Co.

   Records from May 1959 through October 1959

   show range of 5,420 to 9,410 gpd. - Av. 7,710 gpd.

   Employees - Approx. 225 or 34 gpd./employee

2. Well Water - Used for cooling purposes

   150 gpm. or 9,000 gph., 5 days per week

   10 hours per day.

   90,000 gpd. during summer, 20 weeks.

Conclusion:

20 weeks at 100,000 gpd.

32 weeks at 8,000 gpd.

APPENDIX B

CHEMICAL ANALYSES OF WASTES

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-1

East Sewer

	Collected 6/14-15/60			Collected 6/15-16/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	2.8	7.0	6.6	6.2	6.4	6.5
Acidity - Mineral	240	--	--	--	--	--
Acidity - Total	950	--	--	--	--	--
Alkalinity	--	190	190	80	170	200
Suspended Solids						
Total	69	128	82	185	97	75
Volatile	29	41	22	57	33	23
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2865	1015	785	2300	1025	1055
BOD	< 20	< 20	< 20	< 20	< 20	< 20
COD	64	68	40	102	63	33
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	480	100	80	250	100	100
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-2

East Sewer

	Collected 6/16-17/60			Collected 6/17-18/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	6.1	6.8	7.0	2.6	7.3	6.8
Acidity - Mineral	--	--	--	440	--	--
Acidity - Total	--	--	--	1320	--	--
Alkalinity	60	205	220	--	200	210
Suspended Solids						
Total	190	106	72	51	57	56
Volatile	47	25	20	24	18	30
Total - pH 7-8	--	--	--	--	--	--
Total Solids	1945	910	890	4040	795	760
BOD	< 20	< 20	< 20	< 20	< 20	< 20
COD	71	74	42	125	39	15
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	250	50	35	500	50	23
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-3

East Sewer

	Grab Samples			
	4/18/60	4/19/60	4/22/60	4/27/60
pH	6.4	6.6	6.0	3.6
Acidity - Mineral	--	--	--	500
Acidity - Total	--	--	--	5000
Alkalinity	100	80	20	--
Suspended Solids				
Total	87	145	91	58
Volatile	32	46	40	26
Total - pH 7-8	--	--	--	--
Total Solids	1535	1730	2170	14,400
BOD	< 20	< 20	0	0
COD	30	62	485	65
Chromium as Cr	< 0.5	< 0.5	< 0.5	< 0.5
Copper as Cu	0.6	8.0	2.9	12.0
Zinc as Zn	165	150	185	3000
Phenol	< 1	< 1	--	--
Nitrogen as N				
Total	--	--	--	--
Ammonia	--	--	--	--
Organic	--	--	--	--
Total Phosphorus as P	--	--	--	--

All values in milligrams per liter, except pH.

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-4

West Sewer

	Collected 6/15-16/60			Collected 6/16-17/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	7.4	6.9	6.8	7.3	7.3	7.3
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	240	270	260	240	240	310
Suspended Solids						
Total	74	41	42	175	95	115
Volatile	31	17	15	28	16	23
Total - pH 7-8	--	--	--	--	--	--
Total Solids	825	755	800	1030	840	1165
BOD	< 20	< 20	< 20	< 20	< 20	< 20
COD	41	100	29	60	40	37
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	12	12	12	28	17	13
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-5

West Sewer

	Collected 6/17-18/60 Shift			Collected 6/20-21/60 Shift		
	1	2	3	1	2	3
pH	7.2	7.1	6.9	7.3	7.2	7.0
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	220	240	240	240	250	240
Suspended Solids						
Total	66	26	16	50	28	37
Volatile	14	11	7	17	12	16
Total - pH 7-8	--	--	--	--	--	--
Total Solids	900	795	805	840	810	925
BOD	< 20	< 20	< 20	< 20	< 20	< 20
COD	37	33	27	64	31	43
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	32	9	7	10	9	12
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

AMERICAN ZINC COMPANY

CHEMICAL ANALYSES OF WASTES-6

West Sewer

	Grab Samples			
	4/18/60	4/19/60	4/22/60	4/27/60
pH	7.2	7.1	7.4	7.4
Alkalinity	250	340	220	290
Suspended Solids				
Total	65	131	52	86
Volatile	23	28	14	29
Total Solids	840	1010	870	985
BOD.	< 20	< 20	< 20	20
COD	30	38	19	29
Chromium as Cr	< 0.5	< 0.5	< 0.5	< 0.5
Copper as Cu	0.1	0.7	0.4	0.6
Zinc as Zn	12	16	12	25
Phenol	< 1.0	--	--	--

All values in milligrams per liter, except pH.

DARLING FERTILIZER CO.

CHEMICAL ANALYSES OF WASTES-1

North Sewer

	Grab Samples				
	3/23	3/23	3/24	3/30	4/14
pH	3.2	3.2	3.3	2.9	3.3
Acidity - Mineral	900	900	590	1110	710
Acidity - Total	1730	2000	890	1820	1770
Alkalinity	--	--	--	--	--
Suspended Solids					
Total	700	715	500	500	526
Volatile	225	175	74	195	180
Total - pH 7-8	--	--	--	--	--
Total Solids	2175	2360	1290	3935	2935
BOD	--	24	8	33	0
COD	--	270	76	375	535
Chromium as Cr	--	--	--	--	--
Copper as Cu	--	--	--	--	--
Zinc as Zn	--	--	--	--	--
Phenol	--	--	--	--	--
Nitrogen as N					
Total	--	2.0	4.8	29	14.6
Ammonia	--	1.7	1.1	28	4.6
Organic	--	0.3	3.7	1	10.0
Total Phosphorus as P	--	133	43	166	3.3

All values in milligrams per liter, except pH.

DARLING FERTILIZER CO.

CHEMICAL ANALYSES OF WASTES-2

East Sewer

	Grab Samples 3/23	3/30	4/14
pH	--	6.6	7.5
Acidity - Mineral	--	--	--
Acidity - Total	--	--	--
Alkalinity	--	110	110
Suspended Solids			
Total	--	62	36
Volatile	--	16	36
Total - pH 7-8	--	--	--
Total Solids	--	832	336
BOD	4	8	18
COD	37	105	66
Chromium as Cr	--	--	--
Copper as Cu	--	--	--
Zinc as Zn	--	--	--
Phenol	--	--	--
Nitrogen as N			
Total	--	14	5.9
Ammonia	2.8	12	2.4
Organic	<1.0	2	3.5
Total Phosphorus as P	2.3	33	<1.0

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-1

Mississippi Avenue Sewer

	Collected 4/12-13/60 Shift			Collected 4/13-14/60 Shift		
	1	2	3	1	2	3
pH	6.8	7.9	7.9	7.9	8.0	7.7
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	310	420	420	400	420	420
Suspended Solids						
Total	80	48	75	90	52	46
Volatile	62	48	52	54	38	32
Total - pH 7-8	--	--	--	--	--	--
Total Solids	905	900	890	1045	995	905
BOD	25	25	30	15	20	30
COD	185	155	160	160	150	165
Chromium as Cr	1.4	<0.1	0.1	1.1	0.2	0.1
Copper as Cu	8.6	1.0	1.4	6.0	2.0	0.8
Zinc as Zn	1.5	0.7	0.8	3.5	2.7	2.5
Phenol	<1.0	<1.0	<1.0	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-2

Mississippi Avenue Sewer

	Collected 4/18-19/60 Shift			Collected 4/21-22/60 Shift		
	1	2	3	1	2	3
pH	7.9	7.8	7.7	8.0	7.9	7.2
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	450	450	400	395	395	220
Suspended Solids						
Total	50	27	19	46	35	59
Volatile	32	13	10	26	21	27
Total - pH 7-8	--	--	--	--	--	--
Total Solids	920	905	865	860	820	1110
BOD	40	32	40	16	19	23
COD	155	155	155	170	130	155
Chromium as Cr	<0.5	<0.5	<0.5	0.6	<0.5	<0.5
Copper as Cu	6.0	5.0	1.8	4.4	1.0	5.0
Zinc as Zn	0.8	0.8	0.4	14.0	0.9	6.0
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-3

Mississippi Avenue Sewer
(5-Hr. Composites)

	Collected		
	7/27/60	8/4/60	8/5/60
pH	7.0	7.3	7.2
Alkalinity	300	390	375
Copper as Cu	6.4	8.9	7.4
Zinc as Zn	7.8	0.9	0.9

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-4

Control Building Sewer

	Collected 4/18-19/60 Shift			Collected 4/21-22/60 Shift		
	1	2	3	1	2	3
pH	4.6	2.6	2.5	4.5	6.8	6.0
Acidity - Mineral	--	450	800	--	--	--
Acidity - Total	--	1550	2200	--	--	--
Alkalinity	5	--	--	10	90	40
Suspended Solids						
Total	169	23	49	176	258	248
Volatile	60	16	27	64	68	98
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2015	3740	4570	2115	1465	1625
BOD	35	35	15	25	30	20
COD	170	205	210	170	150	150
Chromium as Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper as Cu	80	180	240	10	24	5
Zinc as Zn	60	150	200	80	33	50
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-5

Control Building Sewer

	Collected 4/26-27/60 Shift			Collected 4/27-28/60 Shift		
	1	2	3	1	2	3
pH	3.5	4.0	5.8	4.5	4.6	2.9
Acidity - Mineral	70	30	--	--	--	300
Acidity - Total	760	610	--	--	--	1300
Alkalinity	--	--	40	5	10	--
Suspended Solids						
Total	52	85	250	108	192	40
Volatile	26	37	79	54	79	33
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2570	2300	1650	2420	2305	7970
BOD	29	26	27	30	34	36
COD	190	160	150	225	180	195
Chromium as Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper as Cu	98	90	42	90	69	235
Zinc as Zn	100	86	40	88	88	175
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-6

Control Building Sewer
(5-Hr. Composites)

	Collected 7/27/60	8/4/60	8/5/60
pH	7.0	2.4	2.4
Acidity - Mineral	--	440	550
Acidity - Total	--	1620	1500
Alkalinity	265	--	--
Copper as Cu	8.1	148	126
Zinc as Zn	15	170	165

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-7

Village Lift Station Sewer

	Collected 4/26-27/60 Shift			Collected 4/27-28/60 Shift		
	1	2	3	1	2	3
pH	8.4	8.2	8.1	7.7	7.7	8.0
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	340	350	360	380	360	440
Suspended Solids						
Total	116	68	70	44	50	36
Volatile	60	41	37	42	37	18
Total - pH 7-8	--	--	--	--	--	--
Total Solids	1080	780	790	740	735	715
BOD	12	21	19	10	14	10
COD	130	120	110	115	100	95
Chromium as Cr	12.1	1.6	1.0	0.8	0.8	0.5
Copper as Cu	15.2	4.2	4.2	5.0	4.2	1.8
Zinc as Zn	5.0	1.7	1.7	3.6	2.0	1.3
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-8

Village Lift Station Sewer

	Collected 5/2-3/60			Collected 5/3-4/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	7.6	7.7	7.6	7.6	7.3	7.5
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	340	360	350	350	325	370
Suspended Solids						
Total	69	34	30	34	70	53
Volatile	28	14	11	22	32	25
Total - pH 7-8	--	--	--	--	--	--
Total Solids	825	775	740	895	745	870
BOD	16	22	17	13	14	20
COD	110	100	105	125	130	135
Chromium as Cr	2.5	0.5	0.6	<0.5	1.1	<0.5
Copper as Cu	7.8	2.6	2.0	2.6	6.0	3.0
Zinc as Zn	3.0	1.0	0.8	0.8	2.8	1.4
Phenol	<1.0	<1.0	<1.0	--	--	--
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-9

Village Lift Station Sewer
(5-Hr. Composites)

	Collected 7/27/60	8/4/60	8/5/60
pH	7.2	7.4	7.2
Alkalinity	335	320	330
Copper as Cu	5.9	9.7	5.1
Zinc as Zn	2.1	3.0	2.4

All values in milligrams per liter, except pH.

LEWIN-MATHES COMPANY

CHEMICAL ANALYSES OF WASTES-10

24-In. Storm Sewer

	Grab Samples 4/18/60	4/19/60	4/22/60	4/27/60
pH	7.6	7.6	7.7	7.7
Acidity - Mineral	--	--	--	--
Acidity - Total	--	--	--	--
Alkalinity	100	100	110	130
Suspended Solids				
Total	4	19	9	9
Volatile	3	18	8	4
Total - pH 7-8	--	--	--	--
Total Solids	315	300	325	370
BOD	15	16	0	0
COD	38	18	17	14
Chromium as Cr	<0.5	<0.5	<0.5	<0.5
Copper as Cu	0.2	3.6	0.2	1.0
Zinc as Zn	0.4	0.6	0.5	0.3
Phenol	--	--	--	--
Nitrogen as N				
Total	--	--	--	--
Ammonia	--	--	--	--
Organic	--	--	--	--
Total Phosphorus as P	--	--	--	--

All values in milligrams per liter, except pH.

MIDWEST RUBBER CO.

CHEMICAL ANALYSES OF WASTES-1

Combined Flow

	Collected 3/22-23/60 Shift			Collected 3/23-24/60 Shift		
	1	2	3	1	2	3
pH	7.0	7.3	7.2	7.1	7.1	7.0
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	380	390	390	380	380	400
Suspended Solids						
Total	296	256	328	360	288	200
Volatile	220	196	256	325	260	196
Total - pH 7-8	--	--	--	--	--	--
Total Solids	1045	1045	1180	1250	1165	1015
BOD	85	45	90	110	95	85
COD	505	415	585	815	730	475
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	40	35	45	45	45	30
Phenol	<1	--	--	<1	<1	<1
Nitrogen as N						
Total	7.8	5.3	7.6	9.5	9.5	5.6
Ammonia	1.1	1.1	1.1	2.8	1.1	0.8
Organic	6.7	4.2	6.5	6.7	8.4	4.8
Total Phosphorus as P	<1	<1	<1	2	<1	<1

All values in milligrams per liter, except pH.

MIDWEST RUBBER CO.

CHEMICAL ANALYSES OF WASTES-2

Combined Flow

	Collected 3/30-31/60 Shift			Collected 4/6-7/60 Shift		
	1	2	3	1	2	3
pH	7.4	8.1	8.6	7.3	7.3	7.6
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	470	610	720	460	410	430
Suspended Solids						
Total	230	520	855	660	440	270
Volatile	220	435	535	580	420	240
Total - pH 7-8						
Total Solids	1165	1815	2155	1605	1330	1105
BOD	115	380	525	235	125	90
COD	590	1390	1690	1520	950	600
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	25	15	6	40	40	25
Phenol	--	--	--	--	--	--
Nitrogen as N						
Total	8.0	13.0	18.0	10.0	10.0	7.0
Ammonia	1.7	1.1	0.5	2.5	2.5	2.5
Organic	5.3	11.9	17.5	7.5	7.5	4.5
Total Phosphorus as P	1.3	2.0	2.0	1.3	1.3	1.3

All values in milligrams per liter, except pH.

MOBIL OIL COMPANY

CHEMICAL ANALYSES OF WASTES-1

Combined Flow

	Collected 2/16-17/60 Shift 1	2	3	Collected 2/18-19/60 Shift 1	2	3
pH	10.2	9.4	9.2	9.7	9.6	9.5
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	840	670	660	800	1140	1150
Suspended Solids*						
Total	585	350	420	590	685	830
Volatile	225	145	165	240	230	285
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2565	1805	1770	2380	2355	2650
BOD	810	290	175	310	215	165
COD	1880	830	540	945	735	700
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	--	--	--	--	--	--
Phenol	180	40	14	50	50	25
Nitrogen as N						
Total	45	52	48	46	67	73
Ammonia	39	48	38	44	58	68
Organic	6	4	10	2	9	5
Total Phosphorus as P	2.3	3.3	1.0	2.6	2.0	3.3

All values in milligrams per liter, except pH.
*Suspended Solids include $CaCO_3$ from water softening operations.

MOBIL OIL COMPANY

CHEMICAL ANALYSES OF WASTES-2

Combined Flow

	Collected 2/22-23/60 Shift			Collected 2/24-25/60 Shift		
	1	2	3	1	2	3
pH	9.9	9.0	8.8	8.8	8.9	8.7
Acidity - Mineral	--	--	--	--	--	--
Acidity - Total	--	--	--	--	--	--
Alkalinity	1220	660	600	690	890	880
Suspended Solids*						
Total	755	500	365	610	810	815
Volatile	300	185	140	255	330	315
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2420	1980	1820	1965	2180	2015
BOD	1530	340	190	225	185	175
COD	2990	990	590	665	595	630
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	--	--	--	--	--	--
Zinc as Zn	--	--	--	--	--	--
Phenol	385	88	31	24	26	33
Nitrogen as N						
Total	56	53	67	67	66	67
Ammonia	49	50	61	61	50	60
Organic	7	3	6	6	16	7
Total Phosphorus as P	6.6	6.6	2.5	6.3	4.3	2.7

All values in milligrams per liter, except pH.
*Suspended Solids include $CaCO_3$ from water softening operations.

MOBIL OIL COMPANY

CHEMICAL ANALYSES OF WASTES-3

Special Samples for Phenol

Date	Shift 1	Shift 2	Shift 3
5/18-19/60	19	19	19
5/19-20/60	17	17	11
5/23-24/60	21.5	21	22
5/26-27/60	17.6	16.5	14.3
5/31-6/1	28.6	24.2	24.2
6/1-2/60	18.2	15.4	18.2

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-1

Main Area - 24-In. Sewer

	Collected 5/3-4/60* Shift			Collected 5/8-9/60* Shift		
	1	2	3	1	2	3
pH	2.9	2.9	2.4	3.1	3.1	2.8
Acidity - Mineral	180	150	730	140	150	310
Acidity - Total	260	250	830	240	230	380
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	22	44	21	6	37	32
Volatile	10	13	13	2	19	27
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2040	1800	2150	2150	1995	2445
BOD	--	--	--	165	120	85
COD	--	--	--	510	385	325
Chromium as Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper as Cu	5	12	33	10.2	4.8	3.6
Zinc as Zn	--	--	--	7.0	4.0	3.5
Phenol	16	17	35	44	18	13
Nitrogen as N						
Total	--	--	--	15.4	21.0	11.2
Ammonia	--	--	--	9.8	7.0	7.0
Organic	--	--	--	5.6	14.0	4.2
Total Phosphorus as P	--	--	--	17	13	13

All values in milligrams per liter, except pH.
*Drainage from Dead Creek into sewer.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-2

Main Area - 24-In. Sewer

	Collected 5/15-16/60			Collected 5/18-19/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	3.2	2.6	2.8	2.5	2.5	2.8
Acidity - Mineral	110	570	370	560	590	250
Acidity - Total	260	630	450	690	850	340
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	63	35	41	64	40	11
Volatile	21	31	30	46	32	--
Total - pH 7-8	--	--	--	--	--	--
Total Solids	1900	2175	1640	2025	2310	2240
BOD	75	60	100	90	90	90
COD	435	315	325	435	435	450
Chromium as Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper as Cu	3.0	2.4	1.4	2.0	2.0	2.8
Zinc as Zn	1.0	2.0	1.0	0.9	1.0	0.9
Phenol	17	10	15	19	22.5	38.5
Nitrogen as N						
Total	115	14	8.4	8.1	11.2	7.6
Ammonia	76	--	--	--	--	--
Organic	39	--	--	--	--	--
Total Phosphorus as P	12	10	20	25	73	25

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-3

Main Area - 24-In. Sewer

	Collected 5/20-21/60 Shift			Collected Shift		
	1	2	3	1	2	3
pH	6.4	3.3	2.4			
Acidity - Mineral	--	220	620			
Acidity - Total	--	300	690			
Alkalinity	60	--	--			
Suspended Solids						
Total	84	28	14			
Volatile	19	12	5			
Total - pH 7-8	--	72	80			
Total Solids	2700	3230	2215			
BOD	100	85	160			
COD	550	500	500			
Chromium as Cr	--	--	--			
Copper as Cu	3.0	3.2	--			
Zinc as Zn	1.4	1.2	2.1			
Phenol	18	24	56			
Nitrogen as N						
Total	93	5.3	2.4			
Ammonia	90	--	--			
Organic	3	--	--			
Total Phosphorus as P	4.7	3.3	2.3			

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-4

Main Area - 30-In. Sewer

	Collected 5/8-9/60			Collected 5/15-16/60		
	Shift			Shift		
	1	2	3	1	2	3
pH	3.0	2.8	2.8	2.4	2.6	2.7
Acidity - Mineral	240	410	450	1000	700	500
Acidity - Total	390	550	620	1200	830	610
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	18	27	19	16	24	5
Volatile	16	27	18	16	24	5
Total - pH 7-8	--	--	--	--	--	--
Total Solids	2575	2595	3090	2245	2835	2270
BOD	215	80	110	145	85	145
COD	660	465	365	490	285	470
Chromium as Cr	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper as Cu	1.0	1.0	1.4	0.8	0.5	0.5
Zinc as Zn	0.8	1.0	1.3	0.6	0.6	0.6
Phenol	84	26	28	20	15	43
Nitrogen as N						
Total	11.2	11.2	11.2	30	5	1.4
Ammonia	7.0	4.2	4.2	--	--	--
Organic	4.2	7.0	7.0	--	--	--
Total Phosphorus as P	7.0	4.6	6.0	3.3	2.7	2.7

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-5

Main Area - 30-In. Sewer

	Collected 5/18-19/60 Shift			Collected 5/19-20/60 Shift		
	1	2	3	1	2	3
pH	2.4	2.7	3.1	3.2	2.5	3.2
Acidity - Mineral	780	470	220	130	580	320
Acidity - Total	820	600	360	350	750	650
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	47	24	30	43	11	2
Volatile	37	24	30	38	--	2
Total - pH 7-8	--	--	--	--	--	--
Total Solids	1885	2640	2635	3590	2560	3830
BOD	130	200	290	340	135	175
COD	485	490	735	710	405	485
Chromium as Cr	< 0.5	--	--	<0.5	<0.5	<0.5
Copper as Cu	1.0	0.9	1.0	1.7	1.0	1.2
Zinc as Zn	0.5	0.4	0.3	0.8	0.3	0.3
Phenol	30	70	125	120	34	33
Nitrogen as N						
Total	4.2	5.9	3.5	87	3.6	6.3
Ammonia	--	--	--	27	--	--
Organic	--	--	--	60	--	--
Total Phosphorus as P	13	13	10	12	10	10

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-6

Main Area - 30-In. Sewer

	Collected 5/20-21/60 Shift			Collected Shift		
	1	2	3	1	2	3
pH	2.7	2.6	2.6			
Acidity - Mineral	400	500	610			
Acidity - Total	555	600	880			
Alkalinity	--	--	--			
Suspended Solids						
Total	16	12	8			
Volatile	8	8	5			
Total - pH 7-8	80	72	80			
Total Solids	3405	3160	3020			
BOD	145	120	355			
COD	535	500	740			
Chromium as Cr	--	--	--			
Copper as Cu	1.5	2.2	1.1			
Zinc as Zn	0.4	0.4	0.4			
Phenol	26	36	130			
Nitrogen as N						
Total	44	3.5	2.5			
Ammonia	--	--	--			
Organic	--	--	--			
Total Phosphorus as P	1.9	1.1	0.8			

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-7

North Area - East Main Sewer

	Collected 5/25-26/60 Shift			Collected 5/26-27/60 Shift		
	1	2	3	1	2	3
pH	2.2	2.4	2.2	7.1	2.3	2.4
Acidity - Mineral	1400	750	1350	--	900	750
Acidity - Total	1500	900	1550	--	1050	900
Alkalinity	--	--	--	160	--	--
Suspended Solids						
Total	16	10	16	196	12	6
Volatile	--	--	--	--	8	--
Total - pH 7-8	62	52	54	--	102	90
Total Solids	2125	2795	2470	1810	2205	2650
BOD	95	75	115	22	25	60
COD	470	655	325	130	1180	430
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	0.52	0.42	0.78	0.34	0.28	0.84
Zinc as Zn	5.6	3.0	1.3	1.5	4.9	2.8
Phenol	1.4	0.9	--	5.5	1.2	0.7
Nitrogen as N						
Total	0.6	0.6	0.6	0.8	0.6	0.6
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	0.3	0.3	0.3	0.2	0.3	--

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-8

North Area - East Main Sewer

	Collected 5/31-6/1 Shift			Collected 6/1-2/60 Shift		
	1	2	3	1	2	3
pH	2.2	2.5	2.2	2.3	2.2	2.3
Acidity - Mineral	1600	535	1550	765	1000	850
Acidity - Total	1800	700	1700	880	1150	995
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	8	11	6	14	4	2
Volatile	8	10	6	14	4	2
Total - pH 7-8	--	58	62	63	49	61
Total Solids	2780	2880	2950	3160	2660	3130
BOD	100	130	390	70	210	290
COD	835	550	1390	555	785	850
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	0.56	0.22	0.84	0.48	0.24	0.60
Zinc as Zn	2.8	3.0	3.5	2.5	1.3	1.7
Phenol	0.3	0.2	0.9	3.8	0.4	1.0
Nitrogen as N						
Total	<1.0	<1.0	2.8	<1.0	<1.0	<1.0
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	3.6	2.3	1.6	1.6	<1.0	<1.0

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-9

North Area - East Storm Sewer

	Grab Samples 5/26 1:40 p.m.	5/27 10:45 a.m.	6/1 9:00 a.m.	6/3 12:40 p.m.
pH	6.7	7.1	7.0	8.5
Acidity - Mineral	--	--	--	--
Acidity - Total	--	--	--	--
Alkalinity	120	110	100	140
Suspended Solids				
Total	9	34	54	38
Volatile	--	--	22	36
Total - pH 7-8	--	--	--	--
Total Solids	550	430	425	1800
BOD	20	12	10	Tox.
COD	1165	170	180	1070
Chromium as Cr	--	--	--	--
Copper as Cu	0.20	0.56	0.40	0.80
Zinc as Zn	4.0	3.9	3.0	4.0
Phenol	22	9.5	14.3	5.5
Nitrogen as N				
Total	0.6	0.6	$<$ 1.0	3.0
Ammonia	--	--	--	--
Organic	--	--	--	--
Total Phosphorus as P	0.2	--	1.3	7.6

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-10

North Area - West Main Sewer

	Collected 5/31-6/1 Shift			Collected 6/1-2/60 Shift		
	1	2	3	1	2	3
pH	9.4	3.1	2.4	10.1	11.2	2.1
Acidity - Mineral	--	830	1150	--	--	1750
Acidity - Total	--	1140	1400	--	--	1950
Alkalinity	630	--	--	500	540	--
Suspended Solids						
Total	790	400	130	760	1455	30
Volatile	315	60	56	295	515	30
Total - pH 7-8	--	865	340	--	--	125
Total Solids	7880	8595	8210	12300	8840	7600
BOD	80	85	70	100	80	90
COD	985	1205	1420	920	865	1205
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	0.60	2.9	2.5	1.0	0.60	1.4
Zinc as Zn	8.0	14.4	12.0	1.7	1.7	2.5
Phenol	6.0	5.0	18.2	8.2	7.7	7.7
Nitrogen as N						
Total	<1.0	<1.0	2.8	2.8	<1.0	<1.0
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	1.3	1.0	1.3	1.0	1.3	1.6

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-11

North Area - West Main Sewer

	Collected 6/9-10/60 Shift			Collected 6/10-11/60 Shift		
	1	2	3	1	2	3
pH	8.6	9.4	8.9	2.0	3.3	9.3
Acidity - Mineral	--	--	--	1450	380	--
Acidity - Total	--	--	--	1600	1150	--
Alkalinity	500	660	620	--	--	670
Suspended Solids						
Total	705	895	750	185	2050	995
Volatile	145	360	285	117	2030	210
Total - pH 7-8	--	--	--	230	6500	--
Total Solids	8330	7820	6395	7140	8715	8786
BOD	110	135	105	57	170	135
COD	915	830	720	1110	1055	1055
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	1.4	1.1	0.5	3.4	2.8	0.9
Zinc as Zn	0.9	2.5	1.3	2.5	<1.0	2.0
Phenol	14.3	14.3	13.8	7.0	10.0	18.4
Nitrogen as N						
Total	<1.0	<1.0	<1.0	--	--	--
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	1.3	1.3	1.0	--	--	--

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-12

North Area - West Storm Sewer

	Collected 5/25-26/60 Shift			Collected 5/26-27/60 Shift		
	1	2	3	1	2	3
pH	2.3	2.3	2.2	2.5	2.3	2.3
Acidity - Mineral	1250	1600	1700	700	1050	1500
Acidity - Total	1400	1750	1800	850	1250	1600
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	21	34	20	330	35	5
Volatile	--	--	--	--	--	--
Total - pH 7-8	58	22	30	285	195	100
Total Solids	10700	13420	12795	9445	9415	13635
BOD	25	9	11	9	36	12
COD	1195	1565	1580	1340	1695	1585
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	0.44	0.56	0.24	2.6	3.3	0.44
Zinc as Zn	2.5	5.3	2.1	3.0	3.0	4.5
Phenol	20.5	26.4	31.5	12.8	28.6	30.4
Nitrogen as N						
Total	0.6	5.9	0.8	1.3	2.5	1.0
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	0.2	0.2	0.2	--	--	--

All values in milligrams per liter, except pH.

MONSANTO CHEMICAL CO.

CHEMICAL ANALYSES OF WASTES-13

North Area - West Storm Sewer

	Collected 6/1-2/60 Shift			Collected 6/2-3/60 Shift		
	1	2	3	1	2	3
pH	2.4	2.6	2.4	2.6	2.7	2.7
Acidity - Mineral	1500	810	1500	840	630	770
Acidity - Total	1660	920	1600	955	720	900
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	13	9	10	17	10	12
Volatile	7	9	8	14	8	11
Total - pH 7-8	50	44	30	69	51	58
Total Solids	13015	10910	13500	10360	6920	9745
BOD	120	100	140	98	65	115
COD	1465	1190	1325	1200	805	1330
Chromium as Cr	--	--	--	--	--	--
Copper as Cu	0.4	0.6	0.56	0.40	0.44	0.28
Zinc as Zn	3.2	2.3	2.0	3.5	2.8	1.8
Phenol	22.6	19.2	19.8	20.4	15.4	20.4
Nitrogen as N						
Total	3.0	3.0	$<$1.0	$<$1.0	3.0	$<$1.0
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	$<$1.0	$<$1.0	$<$1.0	$<$1.0	1.6	1.0

All values in milligrams per liter, except pH.

MONSANTO VILLAGE - COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-1

	6-Hour Composites					
	6/21	6/22	6/22	6/23	6/24	6/25
pH	3.5	2.8	3.0	4.1	6.3	3.0
Acidity - Mineral	50	200	190	20	--	180
Acidity - Total	200	390	460	460	--	540
Alkalinity	--	--	--	--	120	--
Suspended Solids						
Total	218	374	199	487	658	191
Volatile	165	323	170	459	562	161
Total - pH 7-8	--	--	--	--	--	442
Total Solids	3230	2570	4125	4095	3080	3010
BOD 5-day	182	186	184	310	250	265
10-day	--	--	--	--	--	--
COD	1035	1500	1005	2395	2335	1550
Copper as Cu	--	--	--	4.2	4.4	9.0
Zinc as Zn	10.0	14.0	25.0	46	6.0	16
Phenol	16	36	18	30	24	39
Nitrogen as N						
Total	--	--	--	16.3	40.9	10.4
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Total Phosphorus as P	--	--	--	12.0	8.7	8.0

All values in milligrams per liter, except pH.

MONSANTO VILLAGE - COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-2

	6 Hour Composites					
	6/27	6/28	6/29	6/30	7/1	7/2
pH	6.6	3.6	1.9	4.8	6.0	7.8
Acidity - Mineral	--	50	2500	--	--	--
Acidity - Total	--	330	2900	--	--	--
Alkalinity	300	--	--	10	80	570
Suspended Solids						
Total	4410	371	83	500	360	586
Volatile	1762	315	73	412	263	440
Total - pH 7-8	--	--	--	--	--	--
Total Solids	8280	2630	4135	2800	2210	4175
BOD 5-day	510	240	175	370	355	315
10-day	525	250	190	525	445	375
COD	5540	1530	630	1690	1200	1900
Copper as Cu	4.6	2.5	0.8	1.5	1.1	0.7
Zinc as Zn	15.2	18.8	9.4	9.6	8.2	1.5
Phenol	17	19	27	29	52	22
Nitrogen as N						
Total	71	18.8	22.7	26.1	16.8	--
Ammonia	--	--	--	--	--	78
Organic	--	--	--	--	--	--
Total Phosphorus as P	31	10.0	6.0	14.0	4.6	--

All values in milligrams per liter, except pH.

MONSANTO VILLAGE - COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-3

	6 Hour Composites					
	7/4	7/5	7/6	7/7	7/8	7/9
pH	2.8	3.0	3.4	2.6	2.8	2.7
Acidity - Mineral	260	130	65	425	210	340
Acidity - Total	405	250	460	595	350	470
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Volatile	--	--	--	--	--	--
Total - pH 7-8	1070	262	596	640	370	165
Total Solids	4685	2655	4450	5915	2800	2905
BOD 5-day	660	130	375	345	235	190
10-day	645	160	485	395	280	265
COD	3525	995	1690	1410	1005	820
Copper as Cu	1.7	1.3	1.0	2.4	1.5	1.7
Zinc as Zn	10.0	7.7	6.0	17	18	15
Phenol	49	14	21	33	23	25
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	13.0	21.0	70.0	17	9	6
Organic	--	--	--	--	--	--
Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

MONSANTO VILLAGE - COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-4

	6 Hour Composites					
	7/11	7/12	7/13	7/14	7/15	7/16
pH	6.8	5.4	4.7	3.4	2.4	2.2
Acidity - Mineral	--	--	--	120	590	900
Acidity - Total	--	--	--	455	740	1065
Alkalinity	185	10	25	--	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Volatile	--	--	--	--	--	--
Total - pH 7-8	685	240	175	205	125	112
Total Solids	3430	2615	--	3450	3230	2580
BOD 5-day	290	300	190	355	145	135
10-day	300	325	290	415	220	155
COD	915	1280	580	975	625	535
Copper as Cu	1.3	1.2	1.6	0.5	1.0	0.8
Zinc as Zn	8	15	12	12	13	8
Phenol	44	29	23	40	41	17
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	7	32	5	5	--	--
Organic	--	--	--	--	--	--
Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

MONSANTO VILLAGE - COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-5

	6 Hour Composites					
	7/18	7/19	7/20	7/21	7/22	7/23
pH	6.3	2.7	2.9	6.1	2.6	2.4
Acidity - Mineral	--	230	140	--	280	385
Acidity - Total	--	480	280	--	610	550
Alkalinity	110	--	--	90	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Volatile	--	--	--	--	--	--
Total - pH 7-8	145	170	180	260	97	150
Total Solids	3000	2290	2720	4050	3480	3180
BOD 5-day	145	290	255	150	300	225
10-day	175	370	335	210	395	280
COD	565	785	770	830	810	770
Copper as Cu	2.8	1.7	1.1	0.9	0.5	0.5
Zinc as Zn	128	15	40	29	50	50
Phenol	22	72	53	25	51	40
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	--	--	--	--	--	--
Orgainic	--	--	--	--	--	--
Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

MOBIL-MONSANTO CHEMICAL COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-1

	6 Hour Composites					
	6/20	6/21	6/22	6/23	6/24	6/25
pH	2.9	2.3	2.4	2.9	5.9	2.7
Acidity - Mineral	180	700	610	280	--	360
Acidity - Total	310	900	810	780	--	720
Alkalinity	--	--	--	--	100	--
Suspended Solids						
Total	86	565	52	44	154	32
Volatile	71	464	42	41	114	30
Total - pH 7-8	--	--	--	120	--	172
Total Solids	3130	4530	3515	5170	4420	3125
BOD 5-day	160	585	625	195	225	165
10-day	--	--	--	--	--	--
COD	795	4490	1780	1570	895	585
Copper as Cu	--	--	--	1.8	3.0	1.2
Zinc as Zn	3.0	3.2	2.3	1.9	7.3	6.7
Phenol	20	28	25	65	36	37
Nitrogen as N						
Total	--	--	--	13.3	19.6	10.6
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Phosphorus as P	--	--	--	27	8.0	4.7

All values in milligrams per liter, except pH.

MOBIL-MONSANTO CHEMICAL COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-2

	6 Hour Composites					
	6/27	6/28	6/29	6/30	7/1	7/2
pH	2.8	2.7	1.9	2.5	3.0	10.4
Acidity - Mineral	300	280	1900	470	150	--
Acidity - Total	520	460	2100	720	280	--
Alkalinity	--	--	--	--	--	950
Suspended Solids						
Total	38	37	36	27	14	--
Volatile	38	35	36	27	14	--
Total - pH 7-8	--	--	--	--	--	214
Total Solids	3550	2690	4260	3155	3750	5785
BOD 5-day	175	105	145	120	240	245
10-day	225	180	200	200	350	275
COD	630	575	615	620	660	650
Copper as Cu	0.3	1.1	0.9	0.9	0.5	0.6
Zinc as Zn	1.0	3.5	10.0	4.3	1.7	0.5
Phenol	23	25	36	32	88	34
Nitrogen as N						
Total	15.1	14.3	37.0	9.0	15.1	96
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Phosphorus as P	4.6	12	6.6	47	6.6	3.3

All values in milligrams per liter, except pH.

MOBIL-MONSANTO CHEMICAL COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-3

	6 Hour Composites					
	7/4	7/5	7/6	7/7	7/8	7/9
pH	2.3	2.5	2.8	2.3	2.4	2.3
Acidity - Mineral	780	440	230	850	455	720
Acidity - Total	860	570	660	970	540	830
Alkalinity	--	--	--	--	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Voltatile	--	--	--	--	--	--
Total - pH 7-8	66	88	86	86	94	62
Total Solids	3880	3510	4635	4630	2950	3570
BOD 5-day	270	165	195	395	205	145
10-day	335	155	230	455	275	285
COD	730	530	745	705	635	610
Copper as Cu	1.0	1.3	0.9	1.2	1.7	1.1
Zinc as Zn	2.4	2.2	2.1	1.7	1.1	1.3
Phenol	74	19	37	55	31	26
Nitrogen as N						
Total	14.6	16.8	20.7	25	34	24
Ammonia	--	--	--	--	--	--
Organic	--	--	--	--	--	--
Phosphorus as P	9.3	10.0	18.0	5.3	00	--

All values in milligrams per liter, except pH.

MOBIL-MONSANTO CHEMICAL COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-4

	6 Hour Composites					
	7/11	7/12	7/13	7/14	7/15	7/16
pH	6.9	2.6	2.6	2.3	2.4	2.3
Acidity - Mineral	--	240	310	750	570	680
Acidity - Total	--	370	400	1085	870	865
Alkalinity	225	--	--	--	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Volatile	60	108	38	90	52	30
Total - pH 708	176	152	110	154	146	56
Total Solids	4145	2855	3195	4320	3820	3260
BOD 5-day	290	190	390	765	325	165
10-day	480	350	420	--	--	--
COD	1000	755	765	2930	925	625
Copper as Cu	0.9	1.8	1.1	0.3	1.3	0.3
Zinc as Zn	0.2	5.0	7.3	7.0	2.3	1.2
Phenol	70	23	30	28	38	17
Nitrogen As N						
Total	--	--	--	--	--	--
Ammonia	9.0	24.0	--	11.0	12.0	66
Organic	--	--	--	--	--	--
Phosphorus as P	--	--	--	--	--	--

all values in milligrams per liter, except pH.

MOBIL-MONSANTO CHEMICAL COMBINED WASTES

CHEMICAL ANALYSES OF WASTES-5

	6 Hour Composites					
	7/18	7/19	7/20	7/21	7/22	7/23
pH	6.3	2.7	2.3	2.4	3.2	2.3
Acidity - Mineral	--	490	505	390	85	535
Acidity - Total	--	690	660	580	330	720
Alkalinity	100	--	--	--	--	--
Suspended Solids						
Total	--	--	--	--	--	--
Volatile	36	30	31	51	59	41
Total - pH 7-8	76	102	85	690	120	99
Total Solids	3380	2430	3140	5790	4540	3010
BOD 5-day	270	165	350	200	670	670
10-day	--	--	395	250	700	730
COD	785	525	810	830	1550	1450
Copper as Cu	0.2	1.0	0.8	1.3	0.9	1.0
Zinc as Zn	0.5	0.8	1.5	1.3	1.3	2.3
Phenol	40	36	55	43	59	196
Nitrogen as N						
Total	--	--	--	--	--	--
Ammonia	127	10	33	64	6.1	6.1
Organic	--	--	--	---	--	---
Phosphorus as P	--	--	--	--	--	--

All values in milligrams per liter, except pH.

APPENDIX C

CONTRIBUTIONS OF POLLUTING SUBSTANCES FROM MONSANTO VILLAGE INDUSTRIES

AMERICAN ZINC COMPANY

Contributions of Suspended Solids, Zinc, Copper

East Sewer

	Flow	Suspended Solids		Zinc		Copper**	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
6/14-15/60							
Shift - 1	435	600*	1030	480	835	6	10
Shift - 2	435	128	220	100	172	6	10
Shift - 3	435	82	140	80	138	6	10
Totals			1390		1145		
6/15-16/60							
Shift - 1	435	185	320	250	430	6	10
Shift - 2	435	97	167	100	172	6	10
Shift - 3	435	75	129	100	173	6	10
Totals			960*		775		
6/16-17/60							
Shift - 1	435	190	328	250	430	6	10
Shift - 2	435	106	183	50	85	6	10
Shift - 3	435	72	124	35	60	6	10
Totals			720*		575		
6/17-18/60							
Shift - 1	435	660*	1150	500	870	6	10
Shift - 2	435	57	98	50	85	6	10
Shift - 3	435	56	97	23	40	6	10
Totals			1345		995		
Daily Totals - Max.			1390		1145		--
- Min.			720		575		--
- Avg.			1100		870		10

*Suspended solids estimated from zinc content
Original samples were acidic.
**Based on average value from grab samples

AMERICAN ZINC COMPANY

Contributions of Suspended Solids, Zinc, Copper

West Sewer

	Flow	Suspended Solids		Zinc		Copper*	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
6/15-16/60							
Shift - 1	3360	74	1000	12	162	0.5	7
Shift - 2	3360	41	552	12	162	0.5	7
Shift - 3	3360	42	568	12	161	0.5	7
Totals			2120		485		
6/16-17/60							
Shift - 1	3360	175	2360	28	378	0.5	7
Shift - 2	3360	95	1280	17	230	0.5	7
Shift - 3	3360	115	1570	13	177	0.5	7
Totals			5210		785		
6/17-18/60							
Shift - 1	3360	66	890	32	433	0.5	7
Shift - 2	3360	26	354	9	122	0.5	7
Shift - 3	3360	16	216	7	95	0.5	7
Totals			1460		650		
6/20-21/60							
Shift - 1	3360	50	675	10	135	0.5	7
Shift - 2	3360	28	380	9	122	0.5	7
Shift - 3	3360	37	500	12	163	0.5	7
Totals			1555		420		
Daily Totals - Max.			5210		785		--
- Min.			1460		420		--
- Avg.			2585		585		7

*Based on average value from grab samples

AMERICAN ZINC COMPANY

Total Daily Contributions to Sewer

	Suspended Solids			Zinc			Copper
	Max.	Min.	Avg.	Max.	Min.	Avg.	Avg.
East Sewer	1,390	720	1,100	1,145	575	870	10
West Sewer	5,210	1,460	2,585	785	420	585	7
Totals, lbs/day	6,600	2,180	3,685	1,930	995	1,455	17

DARLING FERTILIZER COMPANY

Contributions of Suspended Solids and B.O.D.

	Flow	Suspended solids		B.O.D.	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.
East Sewer					
Minimum	7	36	3	4*	--
Maximum	7	62	5	18*	--
Average	7	49	4	10*	--
North Sewer					
Minimum	22	500	132	8*	--
Maximum	22	715	188	33*	--
Average	22	590	156	22*	--
Totals					
Minimum			135		10**
Maximum			195		30**
Average			160		15**

*Values considered invalid because of toxic properties
**Calculated from number of employees @ 0.08 lbs/person

LEWIN-MATHES COMPANY

Constributions of Suspended Solids, Copper, Zinc

Mississippi Avenue Sewer

	Flow	Suspended Solids		Copper		Zinc	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
4/12-13/60							
Shift - 1	740	80	234	8.6	25	1.5	4
Shift - 2	660	48	124	1.0	3	0.7	2
Shift - 3	880	75	262	1.4	5	0.8	3
Totals			620		33		9
4/13-14/60							
Shift - 1	840	90	300	6.0	20	3.5	12
Shift - 2	830	52	172	2.0	7	2.7	9
Shift - 3	870	46	158	0.8	3	2.5	9
Totals			630		30		30
4/18-19/60							
Shift - 1	1020	50	205	6.0	25	0.8	3
Shift - 2	960	27	102	5.0	19	0.8	3
Shift - 3	920	19	68	1.8	6	0.4	1
Totals			375		50		7
4/21-22/60							
Shift - 1	1140	46	210	4.4	20	14.0	64
Shift - 2	1040	35	147	1.0	4	0.9	4
Shift - 3	1100	59	258	5.0	22	6.0	26
Totals			615		46		94
Daily Totals							
Maximum			630		50		94
Minimum			375		30		7
Average			560		40		35

LEWIN-MATHES COMPANY

Contributions of Suspended Solids, Copper, Zinc

Control Building Sewer

	Flow	Suspended Solids		Copper		Zinc	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
4/18-19/60							
Shift - 1	390	169	264	80	120	60	90
Shift - 2	345	23	31	180	240	150	200
Shift - 3	340	49	65	240	320	200	265
Totals			360		680		555
4/21-22/60							
Shift - 1	390	176	275	10	15	80	125
Shift - 2	300	258	302	24	29	33	38
Shift - 3	290	248	290	5	6	50	57
Totals			865		50		220
4/26-27/60							
Shift - 1	380	52	79	98	147	100	150
Shift - 2	330	85	106	90	113	86	110
Shift - 3	250	250	250	42	40	40	40
Totals			435		300		300
4/27-28/60							
Shift - 1	360	108	149	90	130	88	120
Shift - 2	340	192	256	69	92	88	115
Shift - 3	250	40	40	235	235	175	175
Totals			445		460		410
Daily Totals							
Maximum			865		680		555
Minimum			360		50		215
Average			530		370		370

LEWIN-MATHES COMPANY

Contributions of Suspended Solids, Copper, Zinc

Village Lift Station Sewer

	Flow	Suspended Solids		Copper		Zinc	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
4/26-27/60							
Shift - 1	770	116	365	15.2	46	5.0	15
Shift - 2	820	68	220	4.2	14	1.7	6
Shift - 3	800	70	225	4.2	13	1.7	5
Totals			810		73		26
4/27-28/60							
Shift - 1	790	44	142	5.0	16	3.6	11
Shift - 2	780	50	158	4.2	13	2.0	6
Shift - 3	730	36	105	1.8	5	1.3	4
Totals			405		34		21
5/2-3/60							
Shift - 1	790	69	220	7.8	25	3.0	10
Shift - 2	720	34	95	2.6	7	1.0	3
Shift - 3	750	30	90	2.0	6	0.8	2
Totals			405		38		15
5/3-4/60							
Shift - 1	750	34	103	2.6	8	0.8	2
Shift - 2	730	70	205	6.0	18	2.8	8
Shift - 3	770	53	162	3.0	9	1.4	4
Totals			470		35		14
Daily Totals							
Maximum			810		73		26
Minimum			405		34		14
Average			520		45		19

LEWIN-MATHES COMPANY

Total Daily Contributions to Sewer

	Suspended Solids			Copper			Zinc		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Mississippi Avenue Sewer	630	375	560	50	30	40	94	7	35
Control Building Sewer	865	360	530	680	50	370	555	215	370
Village Lift Sta. Sewer	810	405	520	73	34	45	26	14	19
Totals, Lbs/day	2,300	1,140	1,610	803	114	455	675	236	424

MIDWEST RUBBER COMPANY

Contributions of Suspended Solids, B.O.D. and Zinc

	Flow	Suspended Solids		B.O.D.		Zinc	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
3/22-23/60							
Shift - 1	2,260	296	2,700	83	755	40	365
Shift - 2	2,220	256	2,290	47	420	35	315
Shift - 3	2,240	328	2,950	90	810	45	405
Totals			7,940		1,985		1,085
3/23-24/60							
Shift - 1	2,360	360	3,400	110	1,040	45	425
Shift - 2	2,370	288	2,760	96	920	45	430
Shift - 3	2,280	200	1,840	84	770	30	275
Totals			8,000		2,730		1,130
3/30-31/60							
Shift - 1	2,900	230	2,660	114	1,325	25	290
Shift - 2	2,920	520	6,050	382	4,450	15	175
Shift - 3	2,880	855	9,900	525	6,100	6	70
Totals			18,600		11,875		535
4/6-7/60							
Shift - 1	2,900*	660	7,700	234	2,750	40	465
Shift - 2	2,980	440	5,250	124	1,480	40	470
Shift - 3	2,810	270	3,050	92	1,040	25	280
Totals			16,000		5,270		1,215
Daily Totals							
Maximum			18,600		11,875		1,215
Minimum			7,940		1,985		535
Average			12,640		5,460		990

*Estimated value

MOBIL OIL COMPANY

Contributions of B.O.D., Suspended Solids and Phenol

	Flow	Suspended Solids*		B.O.D.		Phenol	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
2/16-17/60							
Shift - 1	895	300	1,080	810	2,900	180	650
Shift - 2	780	194	605	290	905	40	125
Shift - 3	1,315	220	1,155	175	930	14	75
Totals			2,840		4,735		850
2/18-19/60							
Shift - 1	890	320	1,140	312	1,120	50	178
Shift - 2	740	307	910	214	635	50	148
Shift - 3	740	380	1,125	166	490	25	74
Totals			3,175		2,245		400
2/22-23/60							
Shift - 1	1,240	400	1,990	1,530	7,700	385	1,930
Shift - 2	1,370	246	1,350	340	1,875	88	485
Shift - 3	1,180	186	880	190	905	31	150
Totals			4,220		10,480		2,565
2/24-25/60							
Shift - 1	1,145	340	1,560	225	1,030	24	110
Shift - 2	1,285	440	2,280	185	960	26	134
Shift - 3	1,010	420	1,700	175	710	33	132
Totals			5,540		2,700		375
Daily Totals							
Maximum			5,540		10,480		2,565(500)
Minimum			2,840		2,245		375
Average			3,940		5,040(3,700)**		1,050(350)

*Estimated from volatile suspended solids as being 75 percent of actual pollutional suspended solids
**Estimates based on resurvey following changes in plant operation

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D, Phenol

Main Area - 24 In. Sewer

	Flow*	Total Acidity**		Suspended Solids		B.O D.		Phenol	
	gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/3-4/60									
Shift-1	5,400	260	5,600	22	475	- -	- -	16	345
" -2	"	250	5,400	44	950	- -	- -	17	365
" -3	"	830	17,900	21	455	- -	- -	35	755
Totals			28,900		1,880				1,465
5/8-9/60									
Shift-1	5,300	240	5,200	6	130	165	3,500	44	930
" -2	5,200	230	4,780	37	770	120	2,500	18	375
" -3	5,250	380	8,000	32	670	85	1,780	13	275
Totals			18,000		1,570		7,780		1,580
5/15-16/60									
Shift-1	5,450	260	5,700	63	1,370	75	1,630	17	370
" -2	"	630	13,700	35	760	60	1,300	10	215
" -3	"	450	9,800	41	890	100	2,180	15	325
Totals			29,200		3,020		5,100		910
5/18-19/60									
Shift-1	5,500	690	15,200	64	1,410	90	1,980	19	420
" -2	"	850	18,800	40	880	90	1,980	23	510
" -3	"	340	7,500	11	240	90	1,980	39	860
Totals			41,500		2,530		5,940		1,790
5/20-21/60									
Shift-1	5,450	0	0	84	1,830	100	2,180	18	395
" -2	"	300	6,550	28	610	85	1,850	24	525
" -3	5,350	690	15,000	14	300	160	3,500	56	1,220
Totals			21,550		2,740		7,530		2,140

*Flow Estimated from Flows in 30 in. Sewer.
**In terms of $CaCO_3$.

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D., Phenol

Main Area - 30 In. Sewer

	Flow*	Total Acidity**		Suspended Solids		B.O.D.		Phenol	
	gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/8-9/60									
Shift-I	9,650	390	15,000	18	690	215	8,300	84	3,240
" -2	9,500	550	20,900	27	1,025	80	3,040	26	990
" -3	9,600	620	23,000	19	725	110	4,200	28	1,040
Totals			58,900		2,440		15,540		5,270
5/15-16/60									
Shift-1	9,900*	1,200	47,500	16	640	145	5,730	20	790
" -2	"	830	33,000	24	950	85	3,360	15	590
" -3	"	610	24,100	5	200	145	5,730	43	1,700
Totals			104,600		1,790		14,820		3,080
5/18-19/60									
Shift-1	10,000*	820	32,800	47	1,880	130	5,200	30	1,200
" -2	"	600	24,000	24	960	200	8,000	70	2,800
" -3	"	360	14,400	30	1,200	290	11,600	125	5,000
Totals			71,200		4,040		24,800		9,000
5/19-20/60									
Shift-1	10,000	350	14,000	43	1,720	340	13,600	120	4,800
" -2	9,950	750	29,400	11	440	135	5,300	34	1,340
" -3	9,900	650	25,900	2	80	175	6,900	33	1,320
Totals			69,300		2,240		25,800		7,460
5/20-21/60									
Shift-1	9,900	555	22,000	16	635	145	5,750	26	1,040
" -2	9,950	600	23,500	12	480	120	4,800	36	1,420
" -3	9,750	880	34,400	8	315	355	13,850	130	5,090
Totals			79,900		1,430		24,400		7,550

*Estimated Flows.

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D., Phenol
North Area - East Main Sewer

	Flow	Total Acidity		Suspended Solids*		B.O.D.		Phenol	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/25-26/60									
Shift - 1	910	1,500	5,450	16	58	95	340	1.4	5
Shift - 2	897*	900	3,200	10	36	75	270	0.9	3
Shift - 3	884	1,550	5,500	16	57	115	405	--	--
Totals			14,150		150		1,015		8
5/26-27/60									
Shift - 1	856	0	0	196**	670	22	75	5.5	19
Shift - 2	884	900	3,200	12	43	25	90	1.2	4
Shift - 3	837	750	2,520	6	20	60	200	0.7	2
Totals			5,720		730		365		25
5/31-6/1/60									
Shift - 1	884	1,800	6,400	8	28	100	355	0.3	1
Shift - 2	910	700	2,550	11	40	130	470	0.2	1
Shift - 3	965	1,700	6,600	6	23	390	1,510	0.9	4
Totals			15,550		90		2,335		6
6/1-2/60									
Shift - 1	965	880	3,400	14	54	70	270	3.8	15
Shift - 2	940**	1,150	4,300	4	15	210	790	0.4	2
Shift - 3	910	995	3,600	2	7	290	1,090	1.0	4
Totals			11,300		80		2,150		21

*Estimated Flows
**pH of Wastes 7.1

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D., Phenol

North Area - East Storm Sewer - Grab Samples

	Flow	Total Acidity		Suspended Solids		B.O.D.		Phenol	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/26/60	40*	0	0	9	4	20?	?	22	11
5/27/60	40*	0	0	34	16	12?	?	10	5
6/1/60	40*	0	0	54	26	10?	?	14	7
6/3/60	40*	0	0	38	18	0?	?	6	3

* Estimated flow

? Wastes showed toxic properties

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D., Phenol
North Area - West Main Sewer

	Flow	Total Acidity		Suspended Solids		B.O.D.		Phenol	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/31-6/1/60									
Shift - 1	790	0	0	790**	2,500	80	250	6	18
Shift - 2	714	1,140	3,250	400	1,140	85	245	5	14
Shift - 3	735	1,400	4,100	130	380	70	205	18	53
Totals			7,350		4,000		700		85
6/1-2/60									
Shift - 1	787	0	0	760**	2,400	100	315	8	25
Shift - 2	765*	0	0	1,455**	4,460	80	245	8	25
Shift - 3	744	1,950	5,800	30	90	90	270	8	24
Totals			5,800		6,950		830		75
6/9-10/60									
Shift - 1	750*	0	0	705**	2,120	110	330	14	42
Shift - 2	750*	0	0	895**	2,700	135	410	14	42
Shift - 3	750*	0	0	750**	2,260	105	315	14	42
Totals					7,080		1,055		125
6/10-11/60									
Shift - 1	756	1,600	4,850	185	560	57	170	7	21
Shift - 2	744	1,150	3,440	2,050	6,100	170	510	10	30
Shift - 3	744	0	0	995**	2,970	135	405	18	54
Totals			8,290		9,630		1,085		105

*Estimated flow
**pH of wastes above 8.0, suspended solids include precipitated $CaCO_3$

MONSANTO CHEMICAL COMPANY

Contributions of Total Acidity, Suspended Solids, B.O.D., Phenol
North Area - West Storm Sewer

	Flow	Total Acidity		Suspended Solids		B.O.D.		Phenol	
	Gpm.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.	mg/L	Lbs.
5/25-26/60									
Shift - 1	310	1,400	1,740	21	26	25	31	21	26
Shift - 2	275	1,750	1,920	34	37	9	10	26	29
Shift - 3	245	1,800	1,760	20	20	11	11	32	31
Totals			5,420		85		52		85
5/26-27/60									
Shift - 1	290	850	990	285	330	9	11	13	15
Shift - 2	275	1,250	1,380	35	39	36	40	29	32
Shift - 3	150	1,600	960	5	3	12	7	30	18
Totals			3,330		370		58		65
6/1-2/60									
Shift - 1	255	1,660	1,680	13	13	120	122	23	23
Shift - 2	190	920	700	9	7	100	76	19	14
Shift - 3	95	1,600	615	10	4	140	54	20	8
Totals			2,995		24		250		45
6/2-3/60									
Shift - 1	310	955	1,180	17	21	98	120	20	25
Shift - 2	175	720	505	10	7	65	46	15	10
Shift - 3	70	900	255	12	3	115	33	20	6
Totals			1,940		31		200		40

MONSANTO CHEMICAL COMPANY

Total Daily Contributions to Sewer

(Lbs.)

	Total Acidity			Suspended Solids		
	Max.	Min.	Avg.	Max.	Min.	Avg.
Main Area						
24" sewer	41,500	18,000	27,800	3,020	1,570	2,350
30" sewer	104,600	58,900	76,800	4,040	1,430	2,390
North Area						
East main	15,550	5,720	11,680	730	80	260
East storm	0	0	0	26	4	16
West main	8,290	0	5,360	9,630	4,000	6,920
West storm	5,420	1,940	3,420	370	25	130
Totals,lbs/day	175,400	84,600	125,100	17,820	7,110	12,070

MONSANTO CHEMICAL COMPANY

Total Daily Contributions to Sewer

(Lbs.)

	B.O.D.			Phenol		
	Max.	Min.	Avg.	Max.	Min.	Avg.
Main Area						
24" sewer	7,780	5,100	6,590	2,140	910	1,580
30" sewer	25,800	14,820	21,070	9,000	3,080	6,470
North Area						
East main	2,355	365	1,470	25	6	15
East storm	?	?	?	11	3	7
West main	1,085	700	920	125	75	97
West storm	250	52	140	85	40	59
Totals,lbs/day	37,300	21,000	30,200	11,400	4,100	8,200

? Waste showed toxic properties

APPENDIX D

LIME REQUIREMENTS

Lime Requirements

Monsanto Village Combined Wastes, 38 mgd.

Average Mineral Acidity as $CaCO_3$	350 mg./L
Average Total Acidity as $CaCO_3$	600 mg./L

Monsanto Village Wastes contained mineral acidity 70% of time

$Ca(OH)_2$ Requirement

Mineral Acidity Requirement

$$\frac{350 \times 8.35 \times 0.74^{*} \times 0.70}{2000 \times 0.95^{**}} = 0.795 \text{ tons/mil.gal.}$$

$0.795 \times 38 =$ 30.0 ton

Other Acidity to pH 8.0 (75% of time)

$$\frac{250 \times 8.35 \times 0.74^{*} \times 0.75}{2000 \times 0.95^{**}} = 0.61 \text{ tons/mil.gal.}$$

$0.61 \times 38 =$ 23.0 ton

Total 53.0 tons/day

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* Factor for converting $CaCO_3$ to $Ca(OH)_2$

** Assumed purity of $Ca(OH)_2$

Lime Requirements

Mobil-Monsanto Chemical Wastes, 26 mgd.

Average Mineral Acidity as $CaCO_3$	510 mg./L
Average Total Acidity as $CaCO_3$	725 mg./L

Mobil-Monsanto Chemical Wastes contained mineral acidity 83% of time

$Ca(OH)_2$ Requirement

Mineral Acidity Requirement

$$\frac{510 \times 8.35 \times 0.74^{*} \times 0.83}{2000 \times 0.95^{**}} = 1.37 \text{ tons/mil.gal.}$$

$1.37 \times 26 =$ 35.5 ton

Other Acidity Requirement (85% of time)

$$\frac{215 \times 8.35 \times 0.74^{*} \times 0.85}{2000 \times 0.95^{**}} = 0.59 \text{ tons/mil.gal.}$$

$0.59 \times 26 =$ 15.5 ton

Total 51.0 tons/day

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* Factor for converting $CaCO_3$ to $Ca(OH)_2$

** Assumed purity of $Ca(OH)_2$

APPENDIX E

COSTS

BASIS OF COST ESTIMATES

Cost Level and Allowances.

The cost estimates used in this report are based upon construction costs corresponding to an Engineering News-Record (EN-R) Construction Cost Index of 1050.

If several years elapse before bonds are issued, the cost estimates may require adjustment if the prevailing EN-R Index varies substantially from this figure.

Estimated construction costs include allowances for contractor's overhead and profit.

Total capital costs include allowances for construction contingencies, land costs, borings, surveys, materials testing and all administrative, legal, fiscal, and engineering costs.

Annual operating costs include estimated salaries; estimated administrative costs, including allowances for Workmen's Compensation, Social Security, a pension fund and a hospital service plan; estimated comprehensive, public liability, property damage and fire insurance costs; allowances for bond indenture consulting services, general plant maintenance, and equipment renewal; and estimated power and chemical costs.

After the first year of operation, annual costs have been escalated to reflect the trend of rising costs. Salaries, insurance, and administrative costs have been increased 4 percent per year; maintenance, 3 percent per year; chemicals, 2-1/2 percent per year; and power, 1-1/2 percent per year. These allowances are, in our opinion, representative of those to be expected provided present trends continue.

No allowances have been made for rock excavation or pile foundations in any of the work, since we believe none would be required.

We have assumed that the new pumping station required for flood protection will be constructed by the U.S. Corps of Engineers at no cost to the Village.

Construction Schedule.

For purposes of this report we have assumed that the alterations recommended for the sewerage system and existing Main Pumping Station will commence in 1962 and be completed in 1963. Construction of the Waste Water Treatment Plant would commence in 1963 and be completed in 1965. This schedule has been assumed for simplicity in order to reflect full calendar years. Construction should commence at the earliest possible date.

Description of the Project.

Sewer System. Additions and alterations to the sewerage system would consist mainly of providing for the separation of waste water flows between metal-bearing wastes and phenol-acid bearing wastes; and for the construction of separate flow measuring devices for each contributor. Where flows come together in common junction boxes, new dividing walls would be required to maintain separation.

All new sewers would be vitrified clay pipe and the proposed force main on Lewin-Mathes Corp. property would be cast-iron pipe or other suitable material. Cost estimates have been based on cast iron.

Low-Lift Pumping Station. To convert the existing Main Pumping Station to a low-lift station, pumping to the new treatment works, would require separation of the station into two sections, each serving one of the two general types of flows. Three new pumps would be installed in each section, utilizing existing suction and discharge piping insofar as is practical. A connection to the surge chambers would be made and a pressure sewer from each would serve as influent conduits to the treatment works. Since only dry-weather flows would be handled by the converted station, storm flows would overflow to the new Corps of Engineers Pumping Station through a new overflow sewer.

A new screen chamber would be added to the side of the converted station handling the phenol bearing wastes.

Treatment Works. Cost estimates of the treatment works are based on providing the most practical, durable construction possible at a reasonable cost. In consideration of the industrial aspects, the plant would consist mainly of low-cost superstructures, possibly constructed of corrugated asbestos siding over steel framework or other suitable combinations of materials. These could be accented by other materials, such as colored corrugated fiberglass panels, to provide natural lighting and to present a pleasing architectural treatment. Costs for the administration and laboratory building have been based on a superstructure constructed of brick veneer on concrete block or other similar durable construction.

All tanks handling waste water flow and containing mechanical equipment have been estimated as reinforced concrete structures. Although other construction materials could be substituted for lower first costs, shorter service life and higher maintenance costs would be expected, offsetting the initial savings.

The Emergency Storage Basin and Sludge Lagoons would be earth embankment construction. No allowance has been made for lining the storage basin to render it impervious.

Underground piping would be vitrified-clay for waste water and cast iron or steel for sludge. Cost estimates are based on the use of cast-iron pipe for sludge.

Roads and landscaping would be as low cost as practical, although an allowance has been made to enclose the area, except for the sludge lagoons, with a chain-link fence.

Table E-1. Comparison of Capital Costs
Single Plant (Plan I & IV) vs. Separate Plants (Plan II, III, & V)

Item	Estimated Capital Costs				
	Activated Sludge			Trickling Filters	
	Plan I	Plan II	Plan III	Plan IV	Plan V
Flow measuring devices in sewerage system	$ 54,000	$ 54,000	$ 54,000	$ 54,000	$ 54,000
Separation of Wastes	-	275,000	275,000	-	275,000
Pumping Station Improvements	145,000	170,000	170,000	145,000	170,000
Flow measurement in plant	20,000	34,000	34,000	20,000	34,000
Primary Clarifiers	450,000	560,000	560,000	450,000	560,000
Neutralizing Tanks	165,000	115,000	115,000	165,000	115,000
Aeration and Final Settling Tanks	2,140,000	1,410,000	1,410,000	-	-
Trickling Filters	-	-	-	2,180,000	1,450,000
Final Settling Tanks	-	-	-	500,000	-
Recirculation Pumping Station	-	-	-	900,000	700,000
Lime Storage and Feed Building	300,000	300,000	300,000	300,000	300,000
Emergency Storage Basin	170,000	115,000	115,000	170,000	115,000
Oil and Scum Storage Tank	10,000	10,000	10,000	10,000	10,000
Sludge Pumping Facilities	56,000	112,000	56,000	112,000	56,000
Sludge Lagoons	250,000	250,000	125,000	250,000	125,000
Outside Piping and Yard Work	665,000	680,000	655,000	715,000	685,000
Maintenance and Garage Building	110,000	110,000	110,000	110,000	110,000
Administration & Laboratory Building	130,000	130,000	130,000	130,000	130,000
Railroad Siding	75,000	75,000	75,000	75,000	75,000
Total Estimated Construction Cost	$4,740,000	$4,400,000	$4,194,000	$6,286,000	$4,964,000
Engineering and Contingencies	$ 948,000	$ 880,000	$ 839,000	$1,257,000	$ 993,000
Purchase of 122 acres of land	708,000	708,000	708,000	708,000	708,000
Purchase of Special Equipment	68,000	68,000	62,000	68,000	62,000
Financing, Legal, & Administrative Costs	194,000	182,000	175,000	250,000	202,000
Total Estimated Capital Cost	$6,658,000	$6,238,000	$5,978,000	$8,569,000	$6,929,000

Table E-2. Comparison of Annual Costs*
Single Plant (Plan I & IV) vs. Separate Plants (Plan II, III, & V)

	Estimated Annual Costs				
	Activated Sludge			Trickling Filters	
	Plan I	Plan II	Plan III	Plan IV	Plan V
Fixed Costs					
Debt Service					
3.5% 20-yr. General Obligation Bonds for $2,500,000	$ 176,000	$ 176,000	$176,000	$ 176,000	$176,000
5.0% 30-yr. Revenue Bonds for					
$4,158,000	270,500	-	-	-	-
3,738,000	-	243,000	-	-	-
3,478,000	-	-	226,000	-	-
6,069,000	-	-	-	395,000	
4,429,000	-	-	-	-	288,000
Operating Costs					
Salaries	211,000	206,000	201,000	196,000	186,000
Administration & Insurance	62,500	61,500	60,000	57,500	55,500
Maintenance	75,000	68,000	65,000	67,000	60,000
Chemicals	140,000	140,000	140,000	140,000	140,000
Power	160,000	121,000	120,000	108,000	86,000
Total Estimated Annual Cost	$1,095,000	$1,015,500	$988,000	$1,139,500	$991,500

* These cost comparisons show the relative annual costs of all plans considered. Fixed costs will vary depending on how bonds are issued. The above costs are based on selling the entire amounts of the General Obligation Bonds and Revenue Bonds at one time. Operating costs are based on present day costs - no escalation factor has been applied. Costs are rounded off to the nearest $500.

Table E-3. Estimated Sludge Disposal Costs - Plan II-A
All Sludge Lagooned

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 112,000
Sludge Drying Lagoons	250,000
Sludge Distribution Piping	50,000
Estimated Construction Cost	$ 412,000
Sludge Handling Equipment	34,000
Land	550,000
Engineering & Contingencies	82,000
Total Estimated Capital Cost	$1,078,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$70,000
Salaries	20,000
Power	1,000
Maintenance	5,500
Total Estimated Annual Cost	$96,500

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-4. Estimated Sludge Disposal Costs - Plan II-B
All Sludge Dewatered on Vacuum Filters

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 112,000
Concentration Tanks	25,500
Dewatering Building	1,200,000
Emergency Lagoon	16,000
Estimated Construction Cost	$1,353,500
Sludge Handling Equipment	24,000
Land	550,000
Engineering and Contingencies	270,500
Total Estimated Capital Cost	$2,198,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$143,000
Salaries	55,000
Power	4,000
Maintenance	18,000
Total Estimated Annual Cost	$222,000

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-5. Estimated Sludge Disposal Costs - Plan II-C
All Sludge Dewatered on Vacuum Filters and Incinerated

CAPITAL COST

Item	Estimated Cost
Sludge Pumping Facilities	$ 112,000
Concentration Tanks	25,500
Dewatering Building	800,000
Incinerator	930,000
Emergency Lagoon	16,000
Estimated Construction Cost	$1,883,500
Sludge Handling Equipment	16,000
Land	550,000
Engineering and Contingencies	376,500
Total Estimated Capital Cost	$2,826,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$183,800
Salaries	135,000
Power and Fuel	26,000
Maintenance	26,000
Total Estimated Annual Cost	$370,800

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-6. Estimated Sludge Disposal Costs - Plan II-D
All Sludge Pumped to
East St. Louis Sludge Processing Plant

CAPITAL COST

Item	Estimated Cost
Sludge Pumping Facilities	$164,000
Concentration Tanks	25,500
Force Main	42,000
Emergency Lagoon	16,000
Estimated Construction Cost	$247,500
Rights of Way	11,000
Land	550,000
Engineering and Contingencies	49,500
Total Estimated Capital Cost	$858,000

ANNUAL COST

Item	Estimated Cost
Capital Cost Debt Service	$ 55,800
Proportion of Annual Costs for Central Sludge Processing Plant	97,000
Salaries	10,000
Power	2,000
Maintenance	5,500
Total Estimated Annual Cost	$170,300

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-7. Estimated Sludge Disposal Costs - Plan III-A
Primary Sludge Lagooned and
Activated Sludge Wasted to River

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 56,000
Sludge Drying Lagoons	125,000
Sludge Distribution Piping	25,000
Estimated Construction Cost	$206,000
Sludge Handling Equipment	26,000
Land	550,000
Engineering & Contingencies	41,000
Total Estimated Capital Cost	$823,000

ANNUAL COSTS

Debt Service	$ 53,500
Salaries	15,000
Power	500
Maintenance	3,000
Total Estimated Annual Cost	$ 72,000

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-8. Estimated Sludge Disposal Costs - Plan III-B
Primary Sludge Dewatered on
Vacuum Filters - Activated Sludge Wasted to River

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 56,000
Dewatering Building	620,000
Emergency Lagoon	12,500
Estimated Construction Cost	$ 688,500
Sludge Handling Equipment	16,000
Land	550,000
Engineering & Contingencies	137,500
Total Estimated Capital Cost	$1,392,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$ 90,500
Salaries	50,000
Power	2,000
Maintenance	10,000
Total Estimated Annual Cost	$152,500

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-9. Estimated Sludge Disposal Costs - Plan III-C
Primary Sludge Dewatered on Vacuum
Filters and Incinerated - Activated
Sludge Wasted to River

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 56,000
Dewatering Building	400,000
Incinerator Building	455,000
Emergency Lagoon	12,500
Estimated Construction Cost	$ 923,500
Sludge Handling Equipment	8,000
Land	550,000
Engineering & Contingencies	184,500
Total Estimated Capital Cost	$1,666,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$108,500
Salaries	130,000
Power and Fuel	16,000
Maintenance	15,000
Total Estimated Annual Cost	$269,500

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-10. Estimated Sludge Disposal Costs
Plan III-D
Primary Sludge Pumped to Central
Sludge Processing Plant at East St. Louis
Activated Sludge Wasted to River

CAPITAL COSTS

Item	Estimated Cost
Sludge Pumping Facilities	$ 82,000
Force Main	42,000
Emergency Lagoon	12,500
Estimated Construction Cost	$136,500
Rights of Way	11,000
Land	550,000
Engineering & Contingencies	27,500
Total Estimated Capital Cost	$725,000

ANNUAL COSTS

Item	Estimated Cost
Debt Service	$ 47,200
Proportion of Annual Costs for Central Sludge Processing Plant	52,500
Salaries	5,000
Power	1,000
Maintenance	5,000
Total Estimated Annual Costs	$110,700

Note:
Operating Costs are based on present day costs - no escalation factor has been applied.

Table E-11. Annual Operation and Administration Costs
Plan III - Recommended Plan

Year	Salaries, Ins. & Administration	Maintenance	Chemicals	Power	Total
	$	$	$	$	$
1962	10,000	2,000	-	6,500	18,500
1963	15,000	4,000	-	6,600	25,600
1964	15,600	4,400	-	6,700	26,700
1965	293,400	71,000	150,000	125,400	639,800
1966	303,400	73,000	153,500	127,200	657,100
1967	316,000	74,900	157,700	129,000	677,600
1968	328,500	76,900	161,900	130,800	698,100
1969	341,100	79,500	166,000	132,600	719,200
1970	353,600	82,100	170,200	134,400	740,300
1971	368,600	84,700	174,400	136,200	763,900
1972	383,700	87,300	178,600	138,000	787,600
1973	398,700	89,900	182,800	139,800	811,200
1974	413,800	92,500	187,000	142,200	835,500

Note: Costs listed above are rounded to the nearest $500.00 where reported elsewhere.

Table E-12. Estimated Operating Personnel Requirements For Plan III

Position	Number Recommended	Approx. Annual Salary	Estimated Total Cost
Superintendent	1	$8,000	$ 8,000
Plant Operators	4	7,000	28,000
Chemist	1	7,000	7,000
Jr. Chemist	2	5,000	10,000
Lime House Workers	8	5,000	40,000
Sludge Disposal Workers	3	5,000	15,000
Treatment Plant Workers	11	5,000	55,000
Sewer Maintenance Workers	2	5,000	10,000
Spares	4	5,000	20,000
Clerks	2	4,000	8,000
Total	38		
	Total Estimated Labor Cost		$201,000

Note: The table is based on a 40-hr. work week for personnel and 7-day, 3-shift plant operation with salaries estimated at the 1962 wage level.

Dewatering sludge on vacuum filters would require two additional men on each shift for a total of 46 personnel. If incineration were also included, four additional men on each shift would be required for a total of 62.

APPENDIX F

BASIC DESIGN DATA

Table F-1. Basic Design Data

Part I - Phenol-acid Bearing Wastes

1.	Design Flow, mgd.	26.0	
2.	Sewage Flowmeter	Parshall Flume	
3.	Main Pumping Units		
	Number of units	3	
	Capacity of each unit, gpm.	9,000	
4.	Primary Tanks (Circular or Rectangular)	Circular	Rectangular
	No. of units	2	4
	Overflow rate, gal/s.f./day	1650	1630
	Detention time, hrs.	0.98	1.0
5.	Neutralizing Tanks		
	No. of units	2	
	Detention time, minutes	20	
6.	Aeration Tanks		
	No. of units	4	
	Detention time, hrs.	6	
	Return sludge, percent	25	
	Aeration capacity, lb.oxygen/day	40,000	
7.	Final Settling Tanks		
	No. of units	4	
	Overflow rate (gal/s.f./day	2030	
	Detention time, hrs.	1.06	
8.	Emergency Storage Basin		
	Detention time for 26 mgd. flow, hr.	6	
9.	Lime Feeding Facilities		
	Type of feed	slurry	
	Preliminary neutralization capacity, tons per day of lime	100	
	Final neutralization capacity, tons per day of lime	20	

Part II - Metal Bearing Wastes

1.	Design Flow, mgd.	12.0	
2.	Sewage Flowmeter	Parshall Flume	
3.	Main Pumping Units		
	Number of units	3	
	Capacity of each unit, gpm.	4,200	
4.	Primary Settling Tanks (Circular or Rectangular)	Circular	Rectangular
	No. of units	2	4
	Surface overflow rate gal/s.f./day	765	750
	Detention time, hrs.	2.12	2.15

Part III - Sludge Handling

1.	Sludge Lagoons	
	Sludge volume, gpd.	
	Primary, phenol-acid, 4-5% solids	8,000
	Primary, metallic, 4-5% solids	50,000
	Area required per year, acres	20.0
	Total Lagoon area, acres	40.0
2.	Final Disposal area, acres	57.0